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FIG. 1.—TEN-TON ELECTRIC LOCOMOTIVE IN A COAL MINE

MODERN COAL-CUTTING MACHINERY AND MINE RAILWAYS.—[SEE PAGE 120.]

Production of Low Temperature and Refrigeration—II*

The First International Congress of Refrigerative Industries

By L. Marchis

Concluded from Supplement No. 1833, page 103

COLD-STORAGE rooms can be cooled by different methods. In the abattoirs one of the most common methods is to direct dry cold air into the preserving rooms. This air is brought down to a low temperature and sufficiently dried out either by passing over a cold saline solution (spray refrigerator) or by circulation in contact with a coil acting as refrigerant (dry refrigerator). The choice of the type of refrigerator, as M. Barrier has said, is a question of circumstances. Even in the case of meat preservation it makes a difference whether the meat is frozen, that is to say, immunized, or whether it is merely refrigerated (brought to a temperature between zero and 4 deg. C.), where it is more particularly subject to the action of harmful germs. It also makes a difference whether it is a military storehouse, where the meat is only taken out for immediate consumption and the refrigerating chambers are closed up to the time the food is removed, or whether it is a commercial storehouse, where the meat is taken in or brought out daily and is more or less exposed to the air, and where the frequent entries of the workmen carry in noxious gases and impurities. In this latter case the spray evaporator appears preferable on account of the purification and asepsis of the air of the chambers. In the first case, however, the dry evaporator, on account of its greater simplicity and the lowering of the concentration of the brine, presents some real advantages.

It is not sufficient only to produce cold; the cold must be conserved. For this reason the insulation from heat should be considered a question of the first importance in the construction of a cold store. The proper conservation of the contents demands that the temperature of the storage chambers should be as constant as possible. The question of insulating materials, therefore, has been a subject of particular attention by the congress.

A good heat insulator should fulfill the following conditions:

(1) It should be a very poor conductor of heat. If a very thin layer of the insulator is sufficient to obtain proper insulation, the result is both economy of space and economy of the insulating material.

(2) It should have a low specific gravity. This condition is important in insulation installment aboard ship. Its importance is not less, however, in cold-storage warehouses, because of the reduction of cost in transporting it to the work and the possibility of economy in the cost of construction by making possible the construction of very lightly built buildings.

(3) The insulator should be free from odor, and not subject to decomposition, even when moist. This condition is all important in the construction of cold-storage houses designed for the preservation of food stuffs. These absorb very easily bad odors arising from the fermentation of insulating material and become unfit for consumption. For this reason such substances as rice husks, cut straw, oat husks, or cork mixtures made with fermentable substances, such as casein, should be rejected.

(4) The insulating material should absorb to as great a degree as possible the bad odors which are set free in refrigerating chambers and render them less harmful. From this point of view peat or turf sometimes is of great service.

(5) The insulating material should not be hygroscopic. It should not absorb and retain moisture, which is capable of causing it to lose its poor conducting qualities. This is the case with mineral wool, a sort of fibrous glass made out of the slag of blast furnaces.

(6) When by reason of circumstances, such as the breaking of a water tube, etc., an insulating material is wet it should be able to dry out easily and regain its property of poor conduction.

(7) The insulating substances should not be attractive to parasites, mice, rats, etc., nor afford a good culture ground for microbes.

(8) The insulation material should be incombustible, or at least should not propagate combustion started at any point of the mass. A certain number of cork mixtures possess this property; for example, the mixture of cork and pitch. M. Brüll has shown to the congress several different types of entirely fireproof cork mixtures.

(9) When once placed in the packing which makes up the insulating mat, either inside or outside of the wall, the insulating material should not settle and thus produce continuous voids in the insulation. The different wood carbons included under the term charcoal are liable to this disadvantage, when they are used without special precautions.

(10) The insulating materials should not attack the wood, iron, or masonry which comes in contact with them.

(11) The insulating materials should be very easy to work and to apply to the walls of the storage chambers and should possess a certain resistance to bending or crushing.

(12) The insulation should not lose its qualities with time.

It is difficult enough to find an insulation that combines all these qualities. Cork either in granular form or agglomerated, however, is at present the most employed. M. Pasquay has informed the congress that silk waste protected by an impermeable envelope forms an excellent insulation.

The knowledge of the co-efficient of conduction of insulators is of great importance with regard to the thickness which the protecting linings must be to bring down the loss of cold within a certain limit. Different methods have been proposed for determining this. In one of these, the two faces of a plate of the substance are maintained constantly at different temperatures and the quantity of heat passing through the plate in a certain time determined. This may be accurately measured by weighing the amount of ice melted. This is the principle of the well-known physical method called the wall method. It may perhaps be remarked that those who have used this method have not taken precautions against the loss of heat at the edges of the experimental plates. They have not made use of the method of using a guard ring in the form originated by M. Berget.

The other methods for measuring the conductibility are based on Forbes' method. This consists of heating one of the extremities of a long slender bar of the material to be tested. When the system has attained an equilibrium the temperature is taken at different points along the bar, and by the formulæ of Fourrier the coefficient of conductibility can be calculated, if that of emission is known. This latter may be that of a coating or a very thin layer of metal, with which the bar has been previously provided.

A variation of the Forbes method is that of the sectional bar of Lodge. This bar is composed of three sections; the first and the third are of a metal the conductibility of which is known. The second is made up of the material to be tested. The end of the first section is heated and the progression of temperature when equilibrium is established is measured. The general formula for uniform movement of heat in an elongated bar makes possible the calculation of the conductibility of the material composing the second section.

It is this method that M. Desvignes has used in determining the conductibility of several insulating substances. He has worked out the technique so that it can be easily employed in the refrigerating industry.

Some of the results obtained by this method are as follows:

Coefficient of Conductibility.

	Calories for Meter-Degree-Hour.
Cork	0.05 to 0.014
Granular cork	.068
Cork with casein binder	.069
Cork with odorless pitch binder	.087
Cork with sodium silicate binder	.067
Cork mixed with infusorial earth and calcined	.089

As M. Desvignes has remarked, it would perhaps be imprudent to take these figures as a basis for the calculation of loss in a cold-storage plant. The specimens which were used in the tests were picked and were perfectly dry. The given coefficients should be increased not less than 20 per cent. In the application to certain materials some account should be taken of the method of joining. Thus in a partition of cork bricks pointed by cement mortar, where the joints represent in very careful work about 15 per cent of the total volume, the coefficient of conductibility of the brick itself, referred to the total surface of the partition, should be almost doubled. These considerations will show what a difficult question even the approximate calculation of the heating effect due to the walls of the refrigerator may be. The second section has withheld opinion on this question, therefore, and adopted the following resolutions:

(1) That study and research shall be undertaken in the technical schools and laboratories to determine, either by known apparatus or that which shall be subsequently devised, the specific constants of the different insulators which are practically utilizable in the refrigerating industry.

(2) That the characteristic properties and constants to be determined, by account being taken in each case of the degree of humidity, in the following:

The density to be employed.
The coefficient of conductibility.
The resistance to flexure.
The resistance to crushing.
The power of expelling water.
The power of absorbing odors.
The incombustibility.

These constants should be determined under conditions of temperature and thickness of material applicable to the refrigerating industry.

(3) That the second section shall call especial attention to the study of the conductibility as a function of temperature, thickness, degree of humidity, and of other causes capable of influencing the conductibility; for example, the state of division of the material necessary to assure a certain insulation.

(4) That the section requests that the International Bureau of the Refrigeration Congresses, the organization of which has been planned, shall constitute an international commission charged with taking up the study of methods of testing, and co-ordinating, with a view to establishing methods and obtaining comparable results, any researches which are made, in which otherwise the investigators would have their usual latitude.

(5) That it shall be of interest to submit the question of securing uniformity of such methods to the next congress if the researches concerned are sufficiently advanced.

Official instruction up to the present time has been somewhat neglectful of the refrigerating industry. The present-day developments of this industry render more and more necessary the education of engineers who are specialists in this line. For this reason the second section has also enacted the following resolutions:

(1) That theoretical and professional instruction, applied to different present-day phases of the industry of refrigeration, and with a view to new applications, shall be inaugurated in the laboratories and higher technical schools of all countries, this course of instruction to be followed by detailed practical study of important refrigerating establishments and rational experimentation with the machinery there used, under the direction of specialists.

(2) That in order that the necessary scientific equipment and experimental material and the cost of the experiments may be provided for, this instruction should be subsidized by the governments, municipalities, chambers of commerce, industrial societies, agricultural syndicates, and all other individually or collectively interested in the refrigeration industry.

(3) That the general work and the results of researches carried out in these laboratories and schools, as well as those of associations of engineers and manufacturers who are working in refrigeration, should be submitted to the permanent International Bureau and co-ordinated by it, in order that it may publish periodically a bibliographical index, and may compare the results and derive all the useful indications and conclusions possible from them for presentation to the next Congress of Refrigeration for its examination.

III. THE CONSERVATION OF PERISHABLE ARTICLES.

We have now found out how to produce and maintain a low temperature in cold stores. It remains now to study the methods of construction and use of the cold storage rooms, and the rules permitting of the conservation of different sorts of articles. These questions have been the subject of numerous reports and discussions which it would take too much time to digest here. I will, therefore, only indicate some of the most important conclusions on these questions.

The cold air of rooms in a cold storage house should circulate as little as possible from one chamber to another, in order that the odors of certain preserved products may not affect others. In particular, if the refrigeration of the cold store is accomplished

* Translated for the Smithsonian Institution's Annual Report from the Revue générale des Sciences pures et appliquées, Paris, twentieth year, No. 5, March 15th, 1909.

by means of air coolers it is absolutely necessary to have a special air cooler for each series of chambers designed to contain a particular product.

The articles to be preserved should not pass suddenly from the ordinary temperature to the temperature of the storage rooms, or vice versa; in other words, the refrigeration should be progressive. Thus, in abattoirs the warm meat coming from the slaughter rooms is transported by means of an overhead rail into a cold anteroom kept at a temperature of 7 deg. to 8 deg. C. There it undergoes for about twenty-four hours a preliminary cooling, at the termination of which it is carried into the rooms where the air is maintained at a temperature of 0 deg. to 4 deg. C. and a humidity lower than 75 per cent. Salting and treatment of the intestines, the hides, etc., should be carried on in rooms entirely separate from the foregoing, which should be confined solely to the preservation of fresh meat.

The question of the preservation of horticultural products is one of the most difficult in the application of cold to food stuffs. The preservation of apples and pears has been studied in detail in the United States by Mr. G. H. Powell. He has placed results before the congress which demonstrate with the greatest clearness the effect of placing in the refrigerating chamber freshly picked fruits in comparison with those that have been exposed to the air several days after picking. It is necessary to place the sound fruit in the cold fruit chamber soon after it is gathered. Other circumstances also influence its keeping qualities. It is much better if the fruit comes from older trees; it also appears that sandy soils are not favorable to preservation.

Fruits with a thick skin keep much better than those with an easily ruptured covering. The peach, in particular, is one of the most difficult of fruits to preserve. M. Loiseau, horticulturalist at Montreuil, however, has succeeded in keeping this delicate fruit more than a month. According to him, it is especially necessary to maintain the temperature as constant as possible, varying not more than from 0 deg. to 1 deg. C.

Among the recent applications of low temperatures which have been pointed out may be mentioned the use of artificial cold in the manufacture of paraffin and viscose.

Crude petroleum generally contains from 5 to 6 per cent of paraffin in solution. To obtain this paraffin, the petroleum is distilled until it contains from 10 to 25 per cent of paraffin. Then by lowering the temperature of this liquid (paraffin oil) to a degree which varies according to the quality from +16 deg. to —18 deg. C., paraffin is obtained which separates from the oil in the form of crystals which can be separated from the oil by filtration under pressure. The application of refrigerating machines to this purpose makes possible the treatment at one time of large quantities of petroleum. As an example the works of Pardubitz in Bohemia are equipped with machines of a capacity of a million frigories, and produce annually about four million (kilograms) of paraffin.

The artificial silk called viscose is made by drawing through very fine openings a thick solution of cellulose obtained with alkaline or sulpho-alkaline solvents (caustic soda and carbon disulphide). To accomplish this successfully the solution must be allowed to stand in vessels cooled artificially to +2 deg. C. for a month or two before spinning. The solution is then sufficiently pure to be decanted and spun with success.

IV. TRANSPORTATION WITH REFRIGERATION.

The question of transportation of products under refrigerating conditions is one which has justly been a subject of careful consideration by transportation companies both on land and sea.

The refrigerator cars or trains are of several types.

(1) The refrigerator train, consisting of a group of cars, one of which has no capacity for storage, but contains a complete refrigeration plant which feeds the other cars, with which it is connected by suitable piping.

The impossibility of breaking up such a train by uncoupling the cars from each other limits the practical application of these trains, however, except in a few instances. This system was experimented with in 1905 in the transportation of Russian butter from Siberia (from Kourgane to Riga at a mean speed of 15 to 16 kilometers per hour). The cost of the refrigeration, the temperature of the butter being maintained at a mean of 5.5 deg. C., was as high as 0.117 franc per kilogram of butter per day, exclusive of the cost of the refrigerator plant.

In this category must be classified the Russian refrigerator car of the Silitch system. It is mounted on four sets of wheels on bogy trucks and is of the following dimensions: Length, 8 meters; width, 3 meters; height, 2.65 meters; capacity, 120 cubic meters. It is divided into six compartments. Two in the center contain the refrigerating apparatus, while the other four may be charged with goods to be refrigerated.

(2) The lack of elasticity of the refrigerator trains has been remedied by the use of refrigerator or insulated cars. The operation of these cars necessitates, at the starting point, an insulation composed of a refrigerating machine and an apparatus which forces a blast of cold air into the body of the car before and after charging. When the interior temperature of the car has been reduced to the requisite degree, the cold air is shut off and the car hermetically sealed. In Springfield, Mo., there is an installation of this kind capable of cooling 40 cars of bananas at one time to 15 deg. C.

With this type of cars may be compared those where the low temperature is obtained by the previous cooling of brine contained in coils about the roof or walls of the car. The thermo-regulator car of the Maksoutoff system belongs to this type. The saline solution, which cools the air to about 5 deg. C., must be cooled every two days, necessitating refrigerating stations every five or six hundred kilometers.

(3) Besides the tributary cars of the refrigerator trains and those depending on an installation at the point of departure, there are the self-cooling cars; that is to say, cars themselves containing cold-producing agents. These are the most universally used, both in Europe and America.

These may be divided into two great classes: Cars cooled by ice and cars cooled by evaporation of a liquefied gas.

In the ice-cooled cars the low temperature is obtained by means of ice disposed in compartments along the roof, as exemplified in the cars of the Société des Magasins et Transports frigorifigues de France, or along the walls of the car, as exemplified in the American cars and cars of the Moscow-Kazan Railroad. The plan of closing the body of the car completely from the outside air has been generally abandoned. The ice-cooled cars now in use are usually provided with an arrangement which draws in air from the outside and sends it, after cooling it by contact with the ice, to renew the air in the car. The free space remaining for this disposition of the merchandise is about 30 to 40 cubic feet, allowing the introduction of a load of from six to ten tons, according to the nature of the products. By an ice consumption of an average of 400 kilograms per day a temperature varying between 8 deg. and 4 deg. C. is obtained. The degree of humidity is high, however.

The cars cooled by evaporation of a liquid gas (in this case ammonia) carry on the outside two cylindrical tanks of liquid ammonia. This fluid is sent by regulating cocks into coils placed at the two ends of the car on the inside. The ammonia evaporates and absorbs heat, the ammonia gas produced dissolving in water in a tank placed under the car. One car of this variety was experimented with in 1905 in the transportation of butter from Siberia. The cost of refrigeration for butter maintained at a temperature of from 4 deg. to 5 deg. C. was as high as 0.068 franc per kilogram of butter per day.

In the ice-cooled cars of various types experimented with by the same Russian commission the total cost of refrigeration, including all expenses (ice consumption and charging, installation of ice houses, and operation of cars), amounted to 0.009 franc per kilogram of butter.

As the short summary I have just made shows, the First International Congress of Refrigeration has examined with care most of the scientific and technical problems which exist in the refrigerating industry. If it has solved any of these problems it has indicated in the form of resolutions a very great number of others which up to the present have been only incompletely worked out. The next international congress, which will be held in Vienna in 1910, will not be inferior to that at Paris, and will bring us, let it be hoped, in the scientific phase, to some accurate knowledge of the properties of bodies at low temperatures, and in the industrial phase to a uniformity of units of measure and methods of testing machines and insulating material.

Mica Production in India

By E. HARRAN

INDIA is, at the present time, the source of a little over half the world's supply of mica. During the five years, 1904 to 1908, inclusive, the quantity exported rose from 1,825 hundredweights to 41,256 hundredweights, and the value from $415,915 to $1,237,680.

Although a mica-producing country itself, the United States is India's best customer; and of the total quantity of mica produced in the Orient, seventy-five per cent goes to Great Britain, which is the center of distribution for the States and Germany, the latter country taking the next largest quantity after the former.

The mica raised in India is the variety known as "mucovite," and is found in large pegmatite veins traversing mica schists in various parts of the peninsula, principally the east and south. The two principal centers of production are the Nellore district in the Madras presidency and a tract of land about twelve miles broad and sixty miles long which stretches across the junction of the Gaya, Hazaribagh, and Monghyr districts in Bengal. In the latter of the two areas mentioned the mica industry is a very old-established one, and can be traced back for several centuries. In the former, however, the mining of the mineral was only started very recently, consequent on the discovery of rich deposits by prospectors employed by European capital. In this district the deposits occur in pegmatite veins in granite, in micaceous gneiss, in hornblende, and mica schists. The strata vary from a few inches to several hundred feet in thickness. These pegmatite veins (or "dikes" as they are sometimes called) consist of three essential minerals—quartz, felspar, and mica—in varying proportions. In appearance they bear a resemblance to coarse granite, and the best mica is usually found in those veins in which the constituent minerals have crystallized in large masses. Where felspar and quartz are present in small masses, the accompanying mica is usually of little value.

The mica found adjacent to the surface is almost always soft and cracked, quite useless for commercial purposes other than manufacture into the substance known as "micanitte." Clearer and better colored mica is reached lower down in the solid ground; and as the tunnel reaches greater depths, where the rock formation is harder and more uniform, the mineral extracted improves in quality. It is stated that in the United States no more than five per cent of the total yield of the mica mines is sheet mica. In India, however, it is calculated that an average of ten per cent can be cut into plates, the balance being either wasted or converted, in part, into micanitte. General experience shows that the mica mostly demanded from India by America is of the green and ruby colored varieties in sheets of three square inches and upward. India actually produces the mineral in green, ruby, yellow, white, and amber colors. These are divided into clear and spotted or stained varieties, the clear ruby and clear green being the most valuable, fetching as they do, at present, prices between $7,200 and $9,720 a ton. Of the common varieties, all sized sheets are readily obtainable at prices ranging from 18 cents a pound for 2 by 3 inches to $1.71 and 12 cents a pound for the larger sheets. The presence of any metallic insertions in the mineral renders it useless for insulating electrical purposes (for which the bulk of it is required) generally. For these specific purposes the sheets must be flexible, free from cracks, capable of withstanding high pressure, and non-conducting. The Indian mines produce mica, conforming to this last specification, in large quantities.

The mica mines in Bengal are still worked in a very primitive way, in fact, in exactly the same method as they were worked centuries ago, when the principal use the mineral was put to was to fill the apertures of windows for which we now use glass. The mica which generally occurs at the exposed outcrop, on the hill face, of a pegmatite vein, is followed from "book" to "book" by underhand stopping, which results in the production of holes, some of which are now five hundred feet deep. The resultant material excavated, consisting of mica, earth, rock, etc., is brought to the surface by a string of native coolies, being passed in cane baskets from one to another up rudely constructed bamboo ladders. During the rainy season work is completely stopped for some three months, say June, July, and August. At other times, when rain has occurred during the night, the start of work in the morning is delayed for an hour or more while the resultant accummulation of water is being baled out by hand. In Nellore and Mysore in South India, mining operations are carried out in a much more up-to-date manner, as a result of their more recent origin and the attention that European capitalists are directing to them.

"Dessau" Gas for Balloons

IT is but a short time since publicity was first given to the invention of a new method of producing a gas specially adapted for filling balloons. The process was developed at the Deutsche Continental Gas Gesellschaft of Dessau, and the name "Dessau" Gas has accordingly been applied to the product. A report on some of the more recent developments in the new method is given by A. Sander in "Die Umschau." The process consists in subjecting ordinary illuminating gas to a high temperature, whereby the hydrocarbons present are for the most part split up into hydrogen and carbon. The reaction is one of that important class known to the chemist as "contact actions," that is to say, it is greatly assisted by the presence of solid material offering a large surface to the heated gas.

Accordingly in carrying out the process the gas

is led through retorts packed with small charcoal or coke (whose innumerable pores expose an immense surface to the gas), and heated to the proper temperature. The chemical change which takes place is accompanied by 20 per cent increase in volume. This, together with the deposition of carbon which forms part of the change, leads to a product very considerably lighter than the original illuminating gas. In fact, its specific gravity, expressed on the basis of air as unity, is about .2 to .3, whereas that of coal gas is between .4 and .5. The new gas therefore has considerably greater buoyancy or "lifting power" than ordinary coal gas. It contains about 80 to 84 per cent of hydrogen and 5 to 7 per cent methane, and is free from benzene and other hydrocarbons which attack the balloon cover. Its odor is rather more subdued than that of coal gas. The cost of converting illuminating gas into "Dessau" gas is quite low, hardly more than the cost of delivering the former under ordinary conditions from the works to the consumer.

Motor Truck for Hauling Building Stones

A New French Commercial Automobile

By the Paris Correspondent of the Scientific American

Of recent years automobile trucks have come into extensive use for hauling various heavy goods and we have seen an increasing number of cars placed on the market, designed specifically for use in handling special classes of material.

Among cars of this kind we wish to illustrate one which has recently been built for handling heavy loads of cut stone for building purposes in Paris. The ordinary practice in such cases is to place the stone upon a timber rolling truck and draw it along the road. The car which is shown in our illustration is designed with special facilities for loading and unloading the truck with the greatest possible efficiency. In the form of truck used hitherto there was usually provided a swinging platform which could be let down to the ground and then drawn up with its load, using a hand-operated capstan for the purpose. To take a load of stone from the railroad depot or the quays of the Seine to the building site in the city used to require a team of five, six or more horses. The same load can be handled with an automobile truck at a much lower cost owing to the economy in wages, the elimination of the expenditure for maintenance of horses and the greatly increased hauling capacity per day. Another advantage which is well worth considering is the much smaller space which the conveyance occupies in the street, thus avoiding obstructions of the thoroughfare. These considerations have induced the association of building contractors and the Automobile Club to organize a prize contest for motor trucks. A set of rules were drawn up regulating the general design, dimensions, load, speed and other points. A road test was to be made outside the city over a thirty-mile run without a load, at ten miles an hour, and a second test with the truck loaded with six tons or less, the cars being run in this case over a stated route within the city, which included some steep inclines. The speed prescribed for this test was six miles an hour.

The motor truck described in these pages came out as the most successful competitor in this contest and received an award from the Commission. It is built by the well-known French firm Creusot.

During the test just mentioned it carried a load of five tons, representing an aggregate weight of nine tons, over the route which included some grades of as much as 13 per cent, and gave complete satisfaction.

The spring wheels with which it is equipped give a very easy motion on the stone pavement.

This hauling car is made up of a main truck of the usual pattern for vehicles of this description, to which is added a tipping platform that can be let down at the rear to discharge the load. Upon this tipping platform a roller truck travels, which receives the load of stone or other material. On tipping the platform the truck rolls down of its own weight to the ground and is thus automatically unloaded. The platform is pivoted upon an axis located near the rear wheels of the automobile and some distance above the main axle. The pivot is mounted about the middle of the swinging frame, but a little in advance of that point, so that the platform, when empty, will automatically swing down at the back when its front end is released. The driver's seat is placed well forward and lies above the motor, whereby space is economized and the total length of the car is reduced. Not counting the swinging frame, the total length of the chassis is 15 feet 4 inches; the wheel base between front axle and rear axle is 11 feet. The wheels are of a new and special design and carry a set of broad steel tires placed over rubber rings extending between the tires and the hub. The diameter of the front wheels is 2 feet 10 inches, and that of the rear wheels 3 feet 2 inches. The width of the tires is 4 inches in front and 7 inches at the back. The motor is of the four-cylinder type with 5-inch stroke and 4-inch diameter. In normal working it gives 900 revolutions per minute and 30 horse-power. The fuel is either alcohol or gasoline, the tank being located under the driver's seat. The radiator is cooled by a blast of air thrown upon it by a fan, and is located at the front of the car.

The tipping frame is built of longitudinal channel bars with a cross-stiffening of T-irons. Along the side beams extends a T-iron which serves as a rail for the rolling truck carrying the load. In front these bars are curved upward to provide a buffer. An inspection of the drawing will show near the front end of the rolling truck two side plates perforated with round holes. These are provided to furnish a hold for inserting crowbars when loading and unloading. The platform, when loaded, is held in place by a coupling link, which fastens it down upon the chassis at the front end.

THE CREUSOT MOTOR TRUCK. TAKING ON THE LOAD: SECOND STEP

THE CREUSOT MOTOR-TRUCK. TAKING ON THE LOAD: FIRST STEP

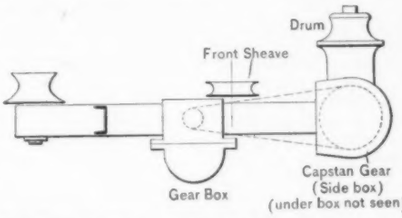
At one side of the chassis will be noticed the capstan which serves for loading and unloading. It is driven by bevel gears, one of these being placed in the circular space below the capstan and the second in the vertical gear case visible just in front of the same. On the shaft of the vertical gear is a sprocket wheel driven by a chain from the motor. To this end the second sprocket is mounted on one of the shafts of the speed-changing box of the car.

Underneath the capstan is a horizontal plate with projections which serve as a clutch to throw the capstan drum on or off the gear shaft. A ratchet and pawl serves as usual to prevent the capstan from slipping backward. A rope is wound around the capstan drum and is then coupled to the rolling truck, passing over a roller upon the tipping frame so that the load can be drawn up, or else let down by the reverse movement. The operations of taking on the load or discharging it are easily carried out by using the present capstan device. To load the rolling truck with the stone upon the car, the swinging frame is tipped so that the rear end comes down upon the ground. Here the channel bars are cut off at an angle so as to give beveled ends in order that the truck may be readily rolled up. The cable is wound in a few turns upon the capstan and thence passes first around a sheave at the center and near the front of the chassis, and then down to be hooked to the front end of the roller truck. The capstan is thrown in gear by the lever of the clutch and the free end of the cable is drawn tight around the drum. As the capstan revolves the roller truck is drawn up, and when a certain point is reached the frame tips forward by the weight of the load and becomes lodged upon the chassis in a horizontal position. Continuing the operation, the roller truck is drawn to the forward end where its movement is limited by the buffers. It is held in this position by the link coupling which works as a guy coupler and is tightened down by a screw so that the truck is held firmly. The cable is 2 inches in diameter and a 4-ton load can be lifted at the rate of 1 foot per second. When it is desired

to work with a heavier load than usual, say a weight of 6 tons, a pulley block is used with the cable so as to reduce the speed by one-half.

For the unloading operation, the capstan is made to draw the roller truck toward the rear of the tipping frame. To this end a pulley is mounted at a point near the rear of the chassis, and the rope is wound around the capstan and passes from here to the rear pulley, being then coupled at the rear end of the roller truck. Working the capstan, therefore, gives the reverse effect and draws the truck backward. When it passes a certain point, its weight causes the frame to tip down to the ground, and the truck rolls down and off the frame. To prevent the motion from becoming too sudden, a braking action is given to the capstan by winding a few turns of a second rope on the free part above the main rope so that drawing upon it will slacken up the speed of the drum.

The stone truck can be replaced by a box body adapted to hold any kind of material. In this way the auto-truck can be kept in continuous service, when there is no stone hauling to do. Commandant Ferrus, one of the members of the official commission, considers that this new car would be very useful in army work for quick transportation and handling of unmounted cannon.



The Creusot Motor Truck.—Details of the Capstan

An Early Project for Wireless Telegraphy

IT will probably be news to most readers that a wireless telegraph company was incorporated by act of Congress in the year 1873. The corporation was entitled the Loomis Aerial Telegraph Company, and its members were Mahlon Loomis, Alexander Elliott, and William N. Chamberlain of Washington, D. C., P. R. Ammidon of Boston, and Isaiah Lukens of Delaware. It was permitted to have a capital stock of $200,000 and to increase the same to $2,000,000, if the interest of the company should require.

All that the act of incorporation tells of the purpose of the company is that "the business and objects of said corporation shall be to develop and utilize the principles and powers of natural electricity, to be used in telegraphing, generating light, heat, and motive power, and otherwise make and operate any machinery run by electricity for any purpose."

The "Loomis Aerial Telegraph" bill was introduced by Representative John A. Bingham of Ohio, referred to the Committee on Commerce, and thence favorably reported by Omar D. Conger of Michigan, on May 21st, 1872. In Mr. Conger's long and flowery speech the theory of the scheme was set forth as follows:

"This theory assumes that the earth itself, the atmosphere surrounding it, and the infinite depth of space encompassing this aerial world, contain a succession of concentric circles or planes of electricity, of which those nearest the earth are perpetually disturbed by oceanic currents, atmospheric changes, alternations of day and night, and the ever-varying effects of solar radiation and lunar influences; but that above these, pierced, perhaps, by the tops of the loftiest mountains, are concentric circles, or vast surrounding seas of undisturbed electricity, which may be affected by any interpenetrating galvanic force from beneath, causing electrical vibrations, or waves, to pass from that point within such electric plane around the world, as upon the surface of some quiet lake one wave circlet follows another from the point of disturbance to the remotest shores. So that from any other mountain top upon the globe any conductor which shall pierce this plane and receive the impression of such vibration may be connected with an indicator, which will mark the length and duration of such vibration, and indicate by any agreed system of notation convertible into human language the messages of the operator at the point of first disturbance; and thus not only from one, but many mountain tops, piercing far above the circumambient atmosphere, the devotee of science and the solemn student of nature may gather the unwritten messages of interest or affection from the silent solitudes of nature and the cerulean depths of heaven with unerring accuracy, and transmit them to the denizens of all lands by the mundane machinery of telegraphic instrumentalities."

Mr. Bingham, more prosaically, said: "I understand that the highest authorities on electricity, both in America and Europe, sustain the theory upon which this project is based, to wit, that the earth is negatively electric, and that the atmosphere above the earth is positively electric increasing in proportion as you ascend above the level of tide-water. The project here proposed is simply to connect the air at a certain altitude (three or four miles if you please, above the level of the sea) with the tide-water level of the earth by means of wires, thereby completing the electric circuit."

Mr. Bingham explained that the required altitude was to be reached by means of mountains, that the company proposed "to utilize electricity wherever diffused through the earth and in the atmosphere of the earth for the purposes of light and heat and motion" (in addition to aerial telegraphy), and said that for three successive years he had introduced the bill and had it referred to the Committee on Commerce.

The principal opponent of the bill (Mr. Charles W. Willard of Vermont) objected to its passage on constitutional grounds, asserting that the power to incorporate belonged to the several States, and that incorporation by Congress conferred an unfair advantage, and he was not moved from this position by the reminder that a telegraph company incorporated by Congress was actually operating wires from the Mississippi to the Pacific. Most of the members of Congress, however, appeared to regard the bill as something of a joke, and let it pass as harmless. Yet this Congress, the forty-second, contained a distinguished array of men of great ability, including, in addition to those already mentioned, James A. Garfield (speaker *pro tempore* and subsequently President of the United States), James G. Blaine (speaker), William P. Frye, Eugene Hale, Benjamin F. Butler, Oakes Ames, George F. Hoar, William H. Barnum, S. S. Cox, Fernando Wood, William A. Wheeler (subsequently Vice-President), Samuel J. Randall, James B. Beck, Michael C. Kerr, Daniel W. Voorhees, Jeremiah M. Rusk, and others.

On the day following the debate, the New York *World* published a long editorial headed "Airy Nothings," filled with aggressive ridicule of the project and of "this electrical Conger," "whose name would lead one to suppose him a denizen rather of the water than of the air."

This all happened thirty-eight years ago. How well may we learn at this time, following the C. Q. D. of the ill-starred "Republic" and the still more recent rescue of Wellman and his brave associates, the value of some "Airy Nothings" of prophecy, and the truth of Mr. Conger's work; "Sir, the visions of the seer are wont to be mistaken for the ravings of insanity. The sublime revelations of prophecy as well as the announcement of important truths have oftentimes been deemed the vagaries of those whom much learning hath made mad."

"This electrical Conger" was the same man who urged the passage of the act which provided funds and authority to send Gen. Greely on his quest of the North Pole, and in honor of whom Greely named Conger Inlet and Fort Conger, celebrated as the abiding place of Greely and his men, and later of Peary and other Arctic explorers.

A description of the actual conditions under which wireless telegraphy is commercially successful would differ little from the theory advanced in the debate on wireless telegraphy to which the House of Representatives listened "with dreamy indifference" thirty-eight years ago.

The Neglected Art of Mastication

THE important part which chewing plays in nutrition is beginning to be recognized. By thorough mastication the food is ground very fine and mixed intimately with saliva, so that it is converted into a soft pulp, which is then formed by the tongue into a bolus that is easily swallowed. But the saliva, the flow of which is increased by chewing, has a more important function than lubrication. It exerts a chemical action on the food, converting its insoluble starchy constituents into soluble sugars, glucose and maltose, and the easily digested dextrin. Mr. Horace Fletcher has made himself famous by his advocacy of thorough mastication, and has raised chewing to a fine art. He makes a study of flavors and chews his food until all its savor has been extracted and it glides down the throat spontaneously.

With many of our modern foods thorough mastication appears superfluous, and we are apt to think it sufficient to cut the food into small pieces, soften it with butter and sauces, and "wash it down" with copious drafts of water and other beverages. This artificial method is not an efficient substitute for the natural method of chewing, and it produces decay of the teeth in addition to numerous digestive troubles. Teeth are, or should be, living tissues, in which metabolism, or renewal of substance, is constantly going on. If they are not used sufficiently they suffer from malnutrition and lack of exercise, and consequently decay. With the decay of the teeth mastication becomes more imperfect and more neglected and thus the two evils, poor teeth and poor chewing, continually aggravate each other.

Teeth need the exercise of chewing hard, solid food. Even children should be allowed to eat the crust of bread and taught to chew this and other food thoroughly.

The value of good teeth and the importance of a rational method of chewing will be demonstrated in various ways at the coming International Hygienic Exhibition in Dresden, where it will be shown, according to *Hygieia*, the circular of the exposition, that the action of the gastric juice is increased by thorough mastication of the food.

A New Cement Compound

"GLYPTOLITH" is a product patented in Europe composed of sand crushed stone and rapid setting Portland cement. It is used for many purposes such as for facing upon almost any kind of material and especially upon concrete and it gives the appearance of stone. The compound adheres strongly and can be easily washed. No special tools are needed for putting it on. Another use is for ornaments and these resemble stone, such as relief work, keystones, capitals of columns, etc. Such ornaments can be made on the spot or produced beforehand and fastened in place when putting on the surface layer. A reinforced concrete construction treated in this way is said to present no difference from natural stone as to outside appearance and can be made as ornamental as desired, being naturally much cheaper.

THE CREUSOT MOTOR TRUCK IN TRANSIT

The Reliability of Electric Furnaces*

Factors in Their Development Under American Conditions

By F. T. Snyder

A few days since a man who had been in the East attending the meetings of an association of engineers, representing an industry that uses a large amount of high-grade steel in various forms, was asked about the electric furnace paper on the programme. He characterized it as "the usual optimistic hopes by the agent of an electric furnace inventor." But without the furnace inventors and without the optimistic hopes that held them for ten years to the expenditure of time and energy and money that was all outgo and results deferred, there would be no commercial electric furnace work to-day to consider. Moreover, it now seems as though the time had come to point out to those who are less closely in touch than ourselves that the electric furnace has grown beyond a question of this or that inventor; has grown beyond a question of hopes to one of commercial use, and is now a matter of engineering and finance; that to-day the electric furnace has achieved reliability.

THE SIEMENS ELECTRIC FURNACE.

But before the time goes by when particular arrangements of electric furnaces are named after their inventors, as such time has gone by for the open hearth furnace and for the crucible furnace, it would seem proper that we should call by the name of its inventor that simplest of all electric steel furnace, in which a single electrode above leads the current through an arc to the steel and a metallic contact with the steel bath below leads the current back to the dynamo. Back in 1880, so far back that the paper describing it was read before the Society of Telegraph Engineers, then the only organization representing electrical engineering, William Siemens built and operated his furnace in which the heat of the electric arc was used to melt steel. This little furnace was a practical furnace. It made good steel. A duplicate of it, copied from the old drawings, will work to-day without difficulty, making its little batch of steel. It is especially fitting that to this same William Siemens the steel industry also owes its open hearth furnace, only second in importance to the blast furnace itself.

As the Siemens electric steel furnace was the first practical electric steel furnace, so now it bids fair to be also the furnace to be used in the greatest numbers. It is characteristic of the electric furnace that it is reliable in small units, and it is in this direction that the industry is tending—the making of some steel castings by many of the gray iron foundries; the making of their own steel castings by many of the larger users. In these small installations the simplicity and reliability of the Siemens electric steel furnace will be important. With proper engineering this single electrode type of steel furnace can be built reliably up to 500 kilowatts, producing 250 tons of steel per month with continuous operation. Many more than a majority of commercial installations will be below this tonnage. A worthy use of this opportunity will be to emphasize the good to electro-chemistry that has lived beyond the life of this man by calling this type of electric furnace the Siemens furnace.

COMMERCIAL RESULTS.

Broadly, reliability is commercial, the ability to make a profitable return on an investment. That the electric steel furnace is reliable in this way is emphasized by the growth of those plants in Europe that are making electric steel exclusively. And beyond steel making, the electric furnace has been commercially reliable so long in the aluminium industry that the general patents have run out. The commercial reliability of the electric furnace in the manufacture of carbide has been for years in evidence with each user of acetylene light. Less widely known, but commercially profitable, has been the electric furnace manufacture of carbon bisulphide, of phosphorus, of graphite, of abrasives, of magnesium for flash lights, of ferroalloys for steel refining, and in the last few years we have seen the reliability of electric furnace operations pledged in the investments of the millions of dollars that are going into the construction of huge electric furnace plants for the production of fertilizers. And it is the commercial reliability of these older electric furnace applications that is back of the reliability of the newer application of the electric furnace to steel. In them was developed the demand that justified the building of electrode factories whose products are now available for steel furnaces. In them was developed the special engineering ability to handle the large electric currents of furnace work. They had their part in the demand for electric current at lower and lower cost. It is these things that have given the Siemens electric steel furnace of thirty years ago, a technical curiosity then, its standing to-day as a reliable industrial tool.

Technically, reliability is a matter of apparatus and men and supplies. These react on each other. Experienced and skilled men can force poor supplies and indifferent apparatus to a commercial output. Apparatus that is inherently self-regulating will permit the use of such men as can be had at a permissible cost. Supplies that have a factor of safety in their constitution will carry the equipment through an overload. Involved in the question of commercial reliability is the element of time. Results must be prompt.

AN AMERICAN ELECTRIC STEEL INDUSTRY.

To make electric steel in the United States means furnaces that are reliable, with American men and American supplies. In the rush of industry reliability cannot afford the time hazard of importation. Europe developed the electric steel furnace industry first, just as it developed the dynamo first, the steam turbine, the large gas engine and steel making itself. There the pressure of competition for opportunity, the abundance of trained technical men and the low cost of capital force enterprise. Safely we may look in America for the same swift overtaking of achievement with the electric steel furnace that has characterized other technical developments. For this reliable American electric furnace supplies are now available and tested. American electrodes can be had in sizes as large as furnace requirements call for. Refractories made in this country have been developed with an ability to stand up well under the higher temperature of the electric steel furnace. Campaigns with roofs of American brick have run into months as against weeks for European practice.

Skilled electric furnacemen are scarce. The rapid installation of furnaces more than absorbs the few who have had an opportunity to become experienced with electric furnaces working in commercial operation. Trials with electric furnacemen imported have not been wholly satisfactory. The drive of the American steel plant does not seem to fit with the methodical nature of the foreign technician. This shortage of skilled furnacemen at permissible costs has thrown more of the burden on the apparatus, has directed American electric steel furnace design toward inherent self-regulation, as we say electrically; toward reliability, as the investor looks at it; toward making it "fool proof," as the man on the job phrases it. Furnace detail that works very well in Europe, with the skilled help available there, has to be designed here to work with the help that can be had. This inherent reliability can now be carried on to an extent that permits taking a steel melter from a crucible or open hearth furnace and putting him on an electric steel furnace, with the assurance that within a week he can be making salable steel regularly. This does not mean making an electrician of him. Actually he knows no more of electricity than he knew of the kinetic theory of gases in his open hearth work but he does know that when the wattmeter needle is in a certain position he has a supply of heat in his furnace, and hot heat at that, and heat that, hot as it may be, will not burn his steel.

BETTER STEEL.

But a reliable furnace and reliable supplies and reliable melters are not all of the commercial reliability of electric steel. The steel produced is different from crucible steel. It is different from open hearth steel. If it were not different the electric furnace would not be used. It is true that under favorable conditions steel can be made cheaper with an electric furnace than in other ways; but the fundamental reason that is speeding electric furnace construction is that the steel is better. Being better means differing chemically, differing physically from the steels of the other furnaces, and this difference chemically and physically must be reckoned with in the subsequent processes the steel goes through. In the foundry the molding must be done for this new material. It is freer from gases. It usually is hotter. The tendency is to lower the carbon for the same tensile strength, and this makes it set at a higher temperature. The improved elimination of phosphorus and sulphur tends in the same direction. In the forge and rolls electric steel shows its additional strength and toughness.

It must be handled from the point of view of its characteristics. It is a mistake simply to consider the electric steel furnace as a substitute for some other kind of a melting furnace. Its introduction can be counted on to mean changes of method, as far as the steel is followed in manufacturing processes, and unless this is clearly recognized there will be disappointment and the reputation of the electric furnace for reliability will suffer.

ELECTRIC FURNACE CONSTRUCTION NO EXPERIMENT.

From a still narrower technical point of view, reliability means freedom from actual breakdown, from the enforced necessity of change in construction and the consequent loss of time and productive capacity. As to this, electric furnace design is now on an engineering basis. Dependence on experiment is now a matter of volition on the part of the investor. It is no longer a necessity. As a piece of engineering apparatus an electric furnace can now be more closely designed to meet narrow specified operating conditions than can an open hearth furnace.

In a recent instance an electric furnace and a small open hearth were installed side by side in a new steel casting shop. The open hearth gave trouble and has been replaced by a better design. The electric furnace, although not of most modern design, has operated without need of alteration. Those details in which an electric furnace differs from established open hearth practice—the electrode holders, the electric regulation, the contacts with the bath of steel—are now rugged and simple. Electrode holders are in evidence that operate with less than one hour's lost time in a hundred heats.

THE RECORD OF A WESTERN PLANT.

Recently I have had occasion to examine carefully in detail the condition of a plant using electric furnaces exclusively, that started operation on a commercial scale in the summer of 1907, and that is quite aged as electric furnace design goes. It is proposed to double the size of the unit and increase the size of this plant fivefold; and this examination was made to determine from the condition of the plant and the operating history what changes in the original design could be made to advantage in the extensions. Incidentally, the examination disclosed a condition of continuing reliability that is worth recording. Substantially all of the original equipment was still in use. The plant, which is in the West, has been operated since its installation by Chinese labor under a white superintendent, and neither the superintendent nor the Chinamen knew more of electricity than is involved in the opening and closing of circuit breakers and the reading of ammeters and voltmeters. One of the power transformers had been replaced, but it was learned after its removal that the trouble was an abraded spot on a terminal that could have been readily repaired on a Sunday at the plant. This particular plant, while not a steel plant, is of interest in showing on many of its operating records a heat development efficiency of over 90 per cent—that is, of the heat equivalent of the energy delivered to the plant by the high potential electric wires, over 90 per cent is transferred to the material under treatment.

CHEAP ELECTRICITY A PRIME FACTOR.

It is to be expected that the success of this new and flexible tool of industry will lead to over enthusiasm and to its application in wrong ways and in wrong places, and that its failure as a panacea for troubles it has properly nothing to do with, will bring setbacks. But back of its present success is the cause of that success, the steadily lowering cost of electric currrent. Thirty years ago the furnace of Siemens worked as an apparatus. It was not until the cost of current dropped below the figure at which the electric furnace was commercially reliable in this country that its industrial application began and its engineering side developed. This dropping of the cost of electricity is still going on, and as it goes on it brings a greater and greater motive force to bear on the installation of electric furnaces. At the same time, unfortunately for industry in general, but fortunately for the electric furnace, the cost of fuel for direct and gaseous heat is slowly but steadily rising.

Summed up more briefly, the facts that an investigator of electric furnace results may expect to find are:

1. That the electric furnace itself has passed from the field of experiment to that of engineering, but that the fields of manufacture using the electric furnace products are still experimental.

2. That the electric furnace is technically reliable and will operate continuously with the men and supplies that are available in this country. That the details are simple and rugged, and that the inherent regulating powers can be made such as to bring it well within the ability of usual plant labor.

3. That the electric furnace is commercially reliable. That when installed with the same business care and adaptation to conditions that should be used with other furnaces, it will earn a profit on the investment, and a profit that is larger than the normal manufacturing profit in proportion as the field is more open.

* A paper read before the Chicago Section of the American Electrochemical Society.

Art and the Engineer*

Combining the Useful With the Beautiful

By James P. Haney

A SHORT time since, New York city made a very extensive showing of charts and figures to explain to her citizens how she spent their money. One room of this Budget Exhibit was given over to the work of the Municipal Art Commission. Here were hung upon the walls a number of plans, some of modest projects—a park fence, a street lamp or fountain, others of large and costly structure; a memorial bridge, a municipal ferry house, a mile of river piers. These plans were all in pairs, and on one of every pair was stamped the word "rejected"; on the other, "accepted." These terse commentaries meant that the Art Commission whose business it is to pass upon every city building, picture, statue, or engineering work, had thrown out certain plans because of their artistic shortcomings. Here was a very practical lesson on the value of art, addressed particularly to the engineer.

To the man trained in shop, or laboratory, the word "art" implies a rather hazy and indefinite something which has to do with the painting of pictures and the making of statues. In a lesser way it is felt to be associated with the concoction of prettiness, and the decoration of bonnets, dresses, and other feminine gear. That, on the contrary, it is a very vital and practical thing, underlying the successful development of huge commercial enterprises, is an idea not grasped.

Yet, in the exhibition to which reference has been made, art appeared as an element which, in one case, led to an accepted plan and a busy firm, and in the other to a rejected design and an idle office. In neither case did the decision depend upon the engineering knowledge involved. The shortcomings were not structural, but artistic. Two plans of equal merit from an engineering point of view were not of equal value in the eyes of the commissioners. It was their business to select the project which was better in design—that is, better in artistic relations. To understand something of these relations and how they are created, must then be important in the training of one who is later to play the part of a creator and builder of structures large and small.

The development of city art commissions is only a new expression of a very old desire. It is the effort of a town's people to secure beauty in their surroundings; and this search for beauty is as old as man. Of all human instincts, there is none deeper than that which leads man to adorn the things he possesses, to decorate his person, his tools, and all his belongings. "This desire," says Carlyle, "is the first spiritual longing of the barbarian." The savage who dwelt in the dim dawn of history has left us no trace by which we can know him, save the drawings with which he decorated his stone cave. His successors, as they have struggled upward through the ages, have in turn left results of similar desire to beautify things, in jewels, in carvings, in temples, and in tombs.

Art has thus meant many things to many men, but after all can be best defined as the search for beauty, and beauty is something which does not lie without, but within us. It is our own response to that which stirs us, it is a personal thrill, and is in us and not in the thing which moves us. Herein is art's great secret; we can know no beauty that we do not feel. Art is dependent upon appreciation born of an emotion. To make such appreciation sensitive to fine forms, beautiful lines, and harmonies of color, its lessons must be taught early in the life of the worker. It is not a thing that can be gained in a few lessons or lectures, as a minor part of some complex curriculum. It is something which must be secured through an effort actually to create fine forms—an effort extended over a series of years through which the student has, by criticism and comparison of his work with that of master craftsmen, learned to refine his taste and to respond—to thrill—to harmonies ever more and more subtle.

One who is to learn what art is must come to understand as his first lesson, that it is not something apart and unrelated to him, something to be raised by others for him to admire. Rather, it is that which he can create himself, indeed something which he must create himself even in the simplest business of his life. The decoration of a room, the hanging of pictures on a wall, the choice of colors in clothes and furnishings, all are of everyday experience, yet they call for just the knowledge of what makes for beauty in line and form. And this same knowledge is daily required throughout the business world. No office can be equipped, no advertising matter printed, no lofts arranged for the sale of goods, or windows devised for their display without appeal to these same principles.

To learn thus, that art is common, is not to learn that it is commonplace. There is a luxury of taste which far surpasses the luxury of wealth. The latter cannot, by extravagant expenditure, secure the results which are attainable by practice in choosing between things esthetically good and bad. Choose, however, we must every day and many times a day, and each choice is a matter of judgment. Such judgment is born of discrimination. We call it "taste." To realize this is to realize that we are all designers, and that we must make pattern every time we dress ourselves, equip an office, or as engineers or architects, plan the simplest of constructed forms.

Art thus seen, is plainly no unnecessary extra to be tacked upon the course which the engineer studies, but a very practical subject, which, rightly taught, will color his judgment and give him breadth and insight far beyond his unschooled fellows. It is something which deals with design both constructive and applied. Its principles are those which underlie all good arrangement, fitness to purpose, proportion, unity, and harmony. The laws of design based on these principles apply just as truly and surely to the planning of a bridge of mighty span, as to the pattern of a door handle or a gas fixture. They apply just as surely to forms we deem unimportant—the factory stack or the gutter curb, as to the monuments and parkways which are a city's pride.

Not until the student has grasped these principles of design does he come to realize how far the engineer controls his audience, how far, in others words, one who understands movement, balance and rhythm of lines and masses, masters the eye of the observer and makes it look where he will. It is this knowledge which guides the architect in his arrangement, the sculptor in his grouping, the painter in his composition. With it Le Page in his Joan of Arc, by a score of subtle devices, fastens our gaze upon the face of the warrior maid. We can look away but for a moment and in a trice some branch or shaft of light or shadow brings us again to the focus of the picture—to the eyes filled with the divine vision.

Design may thus work miracles. It can dignify the plainest of work by elegance of form and proportion. It can ennoble the simplest of materials in structures fine in mass and color. It is within its power to make that which is light seem strong and substantial, to make that which is heavy yet seem instinct of a joyous and dynamic spirit. The latter is the power which resides in the mighty cathedral of Beauvais, whose huge piers lose the crushing sense of weight and break into columns which spring between the painted windows and draw the eye up past the lights of the clerestory into the shadows above, where dim pictures of angels and saints hint of a heaven higher still.

Art, it has been said, has meant many things to many men. The student of shop and laboratory, who would learn something of its stimulus and power, must not be content then to look only at the work of engineers or architects. Man has an inheritance of which great buildings, monuments, roads, and aqueducts are only a part. For centuries art has permeated the life of every country. Our understanding of the past—of the Egyptians, the Greeks, the Romans, and the Teutons, all who lived around the Mediterranean and the Baltic, and all of whose dynasties rose and fell in the mysterious East—has been gotten from their search for beauty. The work of long-dead artists now fills our museums and forms our artistic legacy. It is art's contributions from the past to the work of the artisan of to-day.

This art heritage is to be read in the treasures of a host of kingdoms, whose artisans in metal and in ivory, in clay, in glass, in silk have dignified craftwork and made it precious through their search for beauty in its working. Every material which could be woven, tempered, spun, chased, or tooled, has had in art's history the lifelong study of many master craftsmen. The very difficulties of its working have been made the pleasure of minds that delighted to find new ways in which it might be made to serve art's purposes. To understand this heritage—to read it aright—is to gain a sympathy with those who, through a hundred generations, have made art the sovereign mistress of their daily work, and have served her with lifelong devotion.

Out of this wonderful legacy there stands forth for the engineer structures willed to him as a special inheritance. These may well serve to thrill his heart and stimulate his admiration for his forbears and their work. For him the pyramids, temples, and obelisks spell a lesson which the untaught may not read, the Acropolis stands as a chapter printed in gold, and all the seven hills of Rome as a great volume written by artist engineers. For him the great churches of France and Italy, of Spain and England, and the Low Lands, speak the patient working out of trying problems in the hard school of experience; the long dykes of Holland tell of the will and skill of a wise and courageous people, the great châteaus of France, of men happy in their power of wedding use and beauty. Through these lessons he can learn to read the devotion, the toil, the aspirations, triumphs and failures of those who have gone before. As the heir of the ages, he, now of age himself, may enter into his own.

There is another lesson for the student who studies the structures of the past. As the work of men long gone now teaches him, so he must remember that he will play the part of teacher to those who are to follow. Just as he is designer despite himself, so of necessity he must become instructor to all who are to see his creations. He may design well or ill, and so be a helpful teacher or a vicious one. But teach he must; the very size and publicity of his work make it impossible for him to escape. If it be beautiful it will impress its lesson upon every member of the community. As fine monument, well-proportioned building, gracefully springing viaduct, or soaring tower, it will subtly and surely increase the pleasure of all who see it. If it be ugly and ill adjusted to its surroundings, squat and heavy in its form, or weakly decked forth with small and busy ornament, it will help debase the taste of all who know it.

The young engineer dreams of some great project which may later be delivered to his hands—some huge bridge, some great terminal building, a dominating tower, or a stately church. Art warns him, that if his dream come true, it will be his to create that which may either be a delight to all who see it, or something which because of ugliness, will be a blight upon the city. The bad picture we may hide, the ugly park we may replan, but the structure of steel or stone, or brick or concrete, remains to hearten or to haunt us.

Art then is at once a personal asset of its possessors, and an immense civic and national asset, when expressed in the work of the engineer. Thousands go abroad to see fascinating cities reared by the labor of artist and artisan. These cities profit in no small measure because of the beauty which their architects and engineers have created. Their people delight to show the stranger what knowledge and affection have done to dignify great markets, highways, parks and avenues. There is both an economic and a civic moral in this. And of the two, the civic is the more significant. The engineer whose work is to find place even among the crowded tenements can yet help by his building to add to the pride of those who rejoice that they are citizens of no mean city. Of this pride is born a keener feeling in her welfare, a more loyal devotion to her interests, and a quicker sensitiveness to all that does her ill.

Yet another quickening force appears in the relation of art to the engineer. In all things is a duality. We live as well in a world spiritual as in a world material. Not only esthetic lessons, but spiritual ideas breathe forth from the work of one inspired by art. Thus, in the hands of the engineer art in the past has preached many sermons. Every religion has called upon it for aid, and every faith has seen its hopes made visible in temple, shaft, and aspiring pinnacle. Strength, sobriety, sublimity are ideas as well to be expressed in steel or stone as in the spoken word.

Through the spiritual insight which Art gives, the beauties of Nature are to be read in a new langauge. Her moods of pearly dawn, of gray and rolling cloud, of mystery of night and splendor of the storm, are for those whose sense has wakened to the thousand lines and hues in which she paints her patterns and in which she tells the story of the living world. The fascination of this, its endless variety, are first for those who through art's training have learned to look upon Nature with sympathetic eye—with the painter's vision—which sees beauty in the foggy dripping woodland, and stunning force in the heave and thrust of a huge shoulder of a wave drawing past a headland in the sea.

These things of the spirit once felt cannot but enter into a man's work, be it never so simple and never so confined. If he feels them, they will speak, for one can but talk the language of his mind. If one thinks small thoughts, his work will surely be mean and cramped. If he responds to man's noblest efforts and to Nature's noblest teaching, his creations cannot but reflect this inspiration. Art for the engineer, as for painter, sculptor or architect, for craftsman, writer or musician, is the talisman, the spell which sets the spirit free. Through it the worker may learn that which for ages has been the keenest spur to labor—the delight in service which seeks to praise God through one's craft.

* A lecture delivered before the Stevens Engineering Society.

Modern Coal Cutting Machinery and Mine Railways

Remarkable Labor-Saving Devices

By Frank C. Perkins

MODERN coal mines are now equipped with many most remarkable labor-saving devices operated electrically and by compressed air, including coal cutting machines, punchers and mine haulage engines. The details of construction of the electrical equipment and control of mining locomotives, as utilized in modern practice, are of special interest. Various types of such locomotives are in use, differing more or less in appearance and structure. A good general view of two examples is shown in Figs. 1 and 2 of our illustrations. The former represents a 10-ton electric locomotive delivering bituminous coal out of the rooms of the mine of the Hitchman Coal and Coke Company.

In the view reproduced in Fig. 2 a 12-ton Jeffrey locomotive is seen delivering a train load of coal from the mines of the St. Bernard Coal Company to the tipple. In very low mines and where but a few cars are handled, six-ton locomotives are frequently employed, while for heavy service in the haulage of long trains of heavily loaded cars large locomotives of 16 tons are used. At the mines of the Westmoreland Coal Company, where extra heavy service is required, the locomotives reach a figure of 20 tons. They are equipped with three motors, whose electrical connections are indicated in the accompanying drawing, Fig. 3.

The series wound electric motors are electrically connected so that the same current passes through the armature windings and through the field windings. A flexible cable conducts the current from the trolley harp to a fuse or circuit breaker as a protective device, inclosed non-arcing fuses being usually employed with a lightning arrester connected between the trolley harp and the fuse when the mining locomotives are operated outside of the mines, to any great extent or distance.

From the protective device the electric current is conducted to the controller, the electrical connections of which are indicated in the accompanying drawing (Fig. 3). The controller includes a cylindrical switch for throwing resistance into and out of the motor circuit and also a reversing switch for changing the direction of the current through the field of the motor and the armatures, in order to reverse the direction of travel of the locomotive.

Usually a series-parallel switch is arranged in connection with the reverse switch, so that the motors may be connected either in parallel or in series as desired.

When the power house is located at considerable distance from parts of the mine, the line loss is often so great in distant sections that the motors when connected in series will not receive enough current to start heavy trips, and, in fact, with motors connected in series it is possible for one of the motors to start to slip its wheels before the other motors start. The explanation of this is that as soon as one of the motors starts to slip its wheels it sets up a counter electromotive force which reduces the current flowing, and the result is the other motor does not get sufficient current to develop any great effort, consequently the loads cannot be started. With motors connected in parallel each motor takes current independently of the other, and each exerts its full effort.

FIG. 2.—TWELVE-TON ELECTRIC LOCOMOTIVE OF THE ST. BERNARD COAL COMPANY

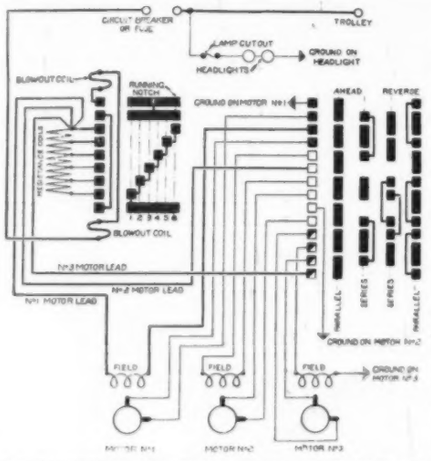


FIG. 3.—DIAGRAM OF CONNECTIONS OF THE THREE-MOTOR TWENTY-TON ELECTRIC LOCOMOTIVE OF THE WESTMORELAND COAL COMPANY

The operation of the controller is as follows: The first resistance contact which comes under its brush permits current to flow through all of the sections of resistance coils in series, thence through the motors to the rail, or in case of a double trolley system to the other trolley wire. The second resistance contact coming under its brush bridges the first section of resistance. The third resistance contact coming under its brush bridges the first and the second section of resistance, and so on until all the sections of resistance are bridged, and the full electromotive force of the line is applied directly to the motor terminals. From the resistance at the controller the current flows to the reversing and series-parallel switch. This switch usually consists of a wooden cylinder inside of the controller case, to which are fitted copper segments, engaging with the contact brushes which are the terminals of the motor leads.

Electric power is held by many mining engineers

FIG. 4.—JEFFREY ELECTRIC COAL CUTTER

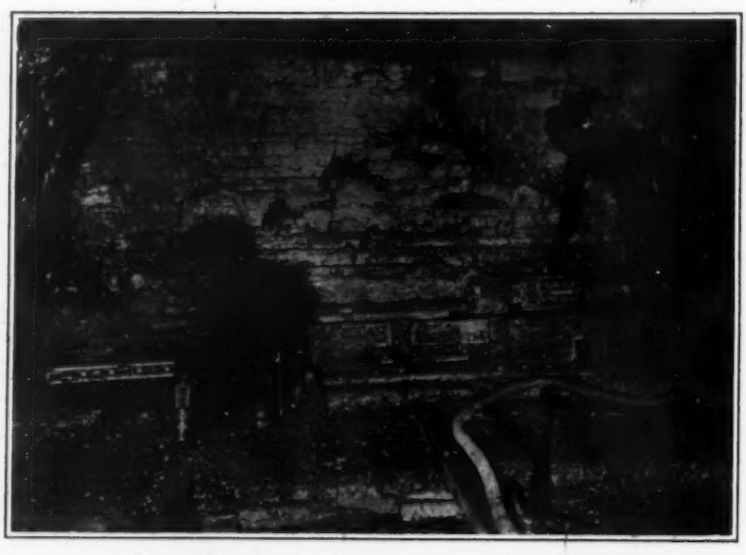


FIG. 5.—JEFFREY PNEUMATIC COAL CUTTER AT WESTMORELAND MINE

to be the most economical and satisfactory power for heavy service coal cutting in modern mines, and it may be of interest to consider the method of operation of these labor-saving devices as utilized in a mine of the new Pittsburg Coal Company. The accompanying illustration (Fig. 4) shows a heavy electric coal cutter of the Jeffrey type in the operation of starting a cut in this mine. In the design and construction of such electric coal-cutting machines all parts are made interchangeable to insure quick repair, as the machines are required to withstand very rough work and the abuse incidental to mine service.

FIG. 6.—PNEUMATIC COAL CUTTER

The cutter chains must be of great strength in order to resist the sudden and excessive strains, and the wearing parts must be specially proportioned to insure the longest life possible, while the electric equipments are required to have ample power to withstand the most severe work with great overload capacity.

The openings in the chain links are arranged at such angles that either chisel or straight pick pointed bits or combinations of both may be used, according to the character of the cutting.

As the depth of the under cut should always approximate the thickness of the vein, the lengths of the cutter frames are usually 5, 6 and 7 feet, while the width of the cutter head for breast machine is generally about 44 inches. In some instances a 39-inch cutter head is utilized where the cuting is hard, or when for any other reason a narrow head is preferable. With these electric coal cutters the speeds of the feed and pull back can be varied to obtain the largest output consistent with the hardness of the cutting, and for this class of service electric power is in almost universal use, being economical in operation and effective in working, allowing a great output for the amount of energy expended and the time, labor and money invested.

Air power coal cutters are extensively used in the mine of the Westmoreland Coal Company. A machine of this kind is displayed in Fig. 6 at the mine entrance. It is mounted on a steel truck so designed that the cutter may be loaded and unloaded with minimum effort and loss of time. In Fig. 5 an air power cutter of the Jeffrey type is shown, just starting the last cut at the right hand rib in the Westmoreland mine. It is of interest to note that this machine was designed for use in mines where ventilation is a perplexing problem, owing to gas and dust, and also in mines where compressed air plants had been installed prior to the application of electricity for underground use. The solid build and resistance to wear of this machine have caused its adoption for a large number of mines where the cutting is hard, and being of the chain type, it makes less fine coal and less dust than other air machines in service. Pneumatic coal cutters similar to those shown in the accompanying illustration have been operated to special advantage at the mines of the Massillon Coal Company, and also in a rather different class of work, for cutting cement limestone in the mine of the York Portland Cement Co.

The early machine coal cutters, driven by compressed air, were of the cutter bar type, as distinct from the chain type now commonly used, and had cylinders set vertically on the frames or carriages. There have been modifications and improvements made from year to year, for the last four decades, as the demand for the machines increased, and new conditions in mining developed, until the form illustrated, known as the air chain mining machine, was evolved. There are to-day only two distanct types of air coal cutters in use; one commonly known as the "puncher," and the other that mentioned in the foregoing.

It is generally conceded that there are in the United States, certain mining districts where the "puncher" machine can be used to greater advantage than the chain or breast type, and this occurs where poor roofs necessitate propping very close to the face; or where "rolls" are met with in the mine, and the coal is frequently cut out; or in mines where an excessive amount of sulphur, in the form of "sulphur balls," occurs in the bottom of the veins where the cuting is to be done. In the majority of mines, however, where the conditions of mining are normal, chain or breast type of machines can be more advantageously and economically used than the "puncher."

Pneumatic mining machines are designed for five, six, or seven-foot undercuts and for seams under five feet in thickness. The five-foot undercut is commonly employed, while for seam ranges from five to six feet the undercut generally desirable is six feet, and for thicker seams seven feet.

In this construction the cutter head can be either thirty-nine or forty-four inches wide, and for all ordinary cutting the forty-four inch cutter head is used, but when the cut is extremely heavy the thirty-nine inch head is preferable. Either chisel or pick point bits, or a combination of both, can be used to suit the character of the coal to be cut, and various speeds of feed and pull back are arranged to suit local conditions. The machines are provided with the necessary jacks to hold them in position, and with trucks adapted to the track gage. For the air hose about fifty feet of one and one-half inch wire wound pipe with couplings is commonly employed.

The air machines have, of course, a special advantage in places where air power is already installed, as they can be put into operation without changes in power equipment or pipe line.

While compressed air puncher machines are used extensively in mines, in many instances electric power only is available. In such cases the so-called pneum-electric puncher is operated, with great economy. This mining machine, which is shown in operation in Figs. 7 and 8, consumed only 7½ horse-power, whereas machines of older design and construction, having an equal cutting capacity, require from 20 to 30 horse-power.

While the application of the electric motor for driving the chain machine was comparatively simple, for the rotative motion of the motor readily lent itself to driving the chain through the medium of gears, the problem of adapting a motor to give reciprocating motion to a pick was far more difficult of solution.

In a percussive tool, the vibrations, if transmitted directly, would be more or less destructive to the electric motor; and while the problem has been considered from almost every conceivable point, and upon every conceivable basis, experience has practically demonstrated that in order to give sufficient flexibility, the blow itself is best struck through the medium of compressed air. In the electrically driven puncher, a compressor cylinder is used and unique means of compressing the air have been devised.

The driving motor is of the ordinary series-wound four-pole type. The shaft of the motor is vertical,

FIG. 7.—A PNEUMATIC ELECTRIC PUNCHER. VIEW SHOWING BIT

FIG. 8.—A PNEUMATIC ELECTRIC PUNCHER. REAR VIEW

MODERN COAL-CUTTING MACHINERY AND MINE RAILWAYS

and the latter is completely inclosed, the frame and gear case cover being made in one piece of cast steel giving strength, minimum weight, and simplicity.

The support of the upper or commutator end of the motor shaft is furnished by a radial ball bearing, while at the lower end is provided a ball thrust bearing to take up the weight of the armature, and also a long bronze bushed bearing to take up the lateral thrust, due to the motor drive.

On account of the necessity of employing an inclosed motor, the question of ventilation and cooling of the various parts became an all-important matter. It is accomplished by the very simple expedient of drawing the air to be compressed in through the armature and field windings at each forward stroke of the air compressing piston. By this means about 28 cubic feet of cool air per minute passes over the heated parts, at a velocity of about 2½ feet per second. This method has been found very effective and is at the same time entirely automatic, requiring no auxiliary appliances.

The circular motion of the motor is, by a novel and peculiarly simple arrangement of gears, transformed into the straight line motion of the primary or air compressing piston located in a cylinder at the forward part of the machine. In the same cylinder is a second piston, connected with the striking pick, but having no mechanical connection with the first. Under the influence of the air which is compressed by the first piston, and delivered through the open ports controlled by the same piston, the second piston is alternately driven backward and forward, but always prevented by the air cushion from striking at either end of the stroke.

The extent to which the pneum-electric machine has been introduced, has fully demonstrated its usefulness under all conditions of mining. In hard or soft coal, thick or thin veins, bad or good roof, rolling or level bottom and narrow or wide work, it has made records which place it at the front, and its performance under these variable conditions has been such that it can justly be classed as a machine entitled to consideration as one of the most important factors in mining equipment.

The thrust, due to the weight of the large reducing gear and its shaft, is taken up, as in the case of the armature, upon a ball bearing, and the lateral thrust is resisted by a long bronze bearing, which extends the entire length of the reducing gear shaft.

The electric pneumatic puncher, as noted in the illustration, Fig. 7, is provided with a reel and cable, the latter being used for conducting the power from the main and cross entries to the face of the coal. The cable is wound on the reel in such a way that connection can be made to the machine and entry wires, without unwinding more than sufficient cable to reach from the entry to within a short distance of the machine. From this point the power is conducted to the machine, by means of a short cable varying in length from 30 to 50 feet. The long cable is of the twin type, the same as commonly used about mines, in connection with other electrical machinery, except that it is unusually well protected from danger of injury by the hard service which it is required to withstand.

It will be seen that this equipment is a great convenience, as by using this cable it becomes unnecessary to carry wires to the face of the coal in the entries and narrow work. Piping, which is required in connection with air machines, is avoided, and the only permanent lines for transmitting the power are the copper wires which are strung in the main and cross entries. The same wires are also used for furnishing power to haulage locomotives, pumps, drills, coal cutting machines, etc.

Environment and Heredity

Modern Studies in Experimental Evolution

By Dr. D. T. MacDougal, Ph.D., LL.D.

Desert Laboratory, Carnegie Institution of Washington

It is unanimously agreed that organisms, plants as well as animals, change individually in aspect, in form and structure of organs, in function and habit, as they encounter swamps, saline areas, gravelly uplands or slopes, climatic differences identifiable with latitude or elevation, and other physical and biological factors. It is generally assumed that these somatic alterations are accommodative and adaptive, making the organism more suitable for the conditions which produce the changes. Such an assumption is an overreaching one. Any analysis of the changes which an organism undergoes after transportation to a new habitat will disclose one of a few alterations which might be of advantage in dealing with the newly encountered conditions but with these are many others, direct, necessitous, atrophic, or hypertrophic as to organs which have no relation whatever to usefulness or fitness. Further, a critical examination fails to disclose any theoretical considerations or any actual facts which would connect inevitably the somatic response with the nature of the excitation, outside of the specialized tropisms in which specific reactions are displayed. Even in these the adjustment is of such nature that a mechanism specially perceptive to contact for example may react to changes in temperature, as illustrated by tendrils, and many similar cases might be cited. It is evident that the soma of a plant or animals is not to be considered as capable of adaptive alterations to every new agency which may cause changes in its form, structure, or functionation.

Recent events in the field of evolution comprehend a number of movements and accomplishments of extraordinary interest. The rediscovery of the facts of alternative inheritance, the formulation of the concepts of equivalent, balanced, paired or differential characters, the results of statistical studies of variability, the analysis of species of various constitution by pedigree cultures, in which the value of fertilization from various sources is carefully measured, the distinction of the biotype or genotype as an hereditary entity, the possibilities in the action of pure lines within a specific group, the cytological contributions of fact and forecast upon the physical aspects of heredity, and lastly the presentation of the facts and allowable generalizations identified with the mutation theory, comprise series of advances, of accretions to knowledge, furnish a broadened foundation for biological science, and disclose additional possibilities in all lines of experimental research with living things, beside opening up new realms for speculative thought, and stimulating the scientific imagination to renewed fruitfulness. Nothing in the whole field of biological research surpasses in importance the problems as to inheritance of environic effects, or as generally stated, "the heredity of acquired characters," a subject which enlists additional attention from its specific sociological bearing.

Among the most noteworthy investigations of environmental effects are those being made by the anthropologist in which somatic calibrations of immigrating races and linguistic studies of peoples of known origin, geographical movement, and established relationship are being used to great advantage. No more fascinating chapters of scientific literature are to be found than those which delineate the history movements, segregations, and habitual reactions of Polynesian islanders, of North American Indians, or of Asiatic peoples, yet their value as actual contributions to biology is hardly recognized. The investigator of problems in anthropology has the advantage of dealing with an animal whose psychology, history, traditions, and records are readily intelligible to him, so that a much wider range of facts may be brought within the zone of reliability than when we deal with an organism whose actions are but imperfectly understood.

If a general view be taken of the available information of interest in this connection, three classes of facts will be discerned. One group is comprised in the mass of information obtained by the operations of the horticulturist, the agriculturist, and the breeder as to the behavior of crops, plants, and domestic animals, when transferred from one habitat to another. The greater part of such data is the result of observations which do not comply with the ordinary requirements in the avoidance of error so that strict comparisons as to the behavior of organisms under the conditions of various habitats are impossible. A consideration of the literature yields many suggestions for experimental research and the simple generalization that the direct effects of climatic complexes on the seasonal cycle, and upon color, or structural features of the individual, may be repeated or carried over two or three generations, in a habitat where the specific casual combinations are lacking. This is the available total of knowledge furnished us by economic operations, and by the introduction operation of botanical gardens and plantations.

A survey of the activities of the biological laboratories of the world during the last five years reveals the fact that an enormous amount of attention is being paid to the subject and that already results of very great importance to the student of evolution have been secured. The nature of these contributions and the increase of information accruing from them may be best illustrated by a citation of some of the more notable experiments.

Pringsheim after a comprehensive review of his own work and of other available evidence obtained by a study of accommodations or adaptations of yeast and bacteria to unusual temperatures, culture media, and poisons, concludes that some of these variations are fixed and transmissible both asexually and by spores, while others are not. There are a number of records of the appearance of definite qualities or morphological characters in the yeasts, which are transmissible and permanent. These departures were so striking as to be capable of being regarded as mutational, and their origin has been ascribed to the influence of the environment by experimentors of notable skill, such as Beijerinck, Winogradsky, Lepeschkin, Hansen, and Barber. It may be recalled in this connection, that environic responses are generally sudden, and that the entire range of departure may be made in a single generation, at most in two or three.

Klebs, who has long been concerned with the morphogenic reactions of plants, has determined a series of conditions under which the stages of mycelial development, asexual zoospore and sexual or oospore formations in filamentous fungi may be inhibited or variously interchanged. Much more important reactions were obtained from *Sempervivum*, the live-forever of the garden. In this plant, dense rosettes or propagative bodies are formed at the ends of some branches, and inflorescences were replaced by single flowers by experimental excitation: The number and arrangement of the floral organs as well as of the stamens and carpels could be altered. Furthermore, the deviations in question were found to be transmissible to the second or third generation in guarded seed-reproductions.

The results of Woltereck with *Daphnia*, a small crustacean, offer something by way of contrast, and also serve to illustrate the necessity for continuation of parallel cultures for the purpose of comparison of divergent forms and the normal. The particular group of this crustacean furnishing the experimental material is taken to be very variable, and it was subjected to over-feeding with the immediate result that the variability of the form of the head appeared to be widened, the size of this structure being increased. This disappeared when lots from the culture were restored to normal conditions in the earlier stage of the work. After three or four months of over-feeding, the form of the head came within narrower limits, and fewer aberrants were seen, while lots returned to normal conditions, showed a slower restoration of the original form of the head. Two years after the cultures were begun, it was found that the original head form was not displayed by young restored to normal nutrition conditions, the larger helmet being persistent. It seems fairly certain that a new genotype resulted from the long-continued action of the culture medium.

The fortunate experience of Zederbauer with Capsella has yielded some conclusions of exceptional importance. A genotype of *Capsella Bursa-pastoris* resembling *taraxicafolium* was found on the lower plains of Asia Minor, and displayed the well-known characters of this form, including broad leaves, whitish flowers, and stems 30 to 40 centimeters high. A highway leads from these regions to a plateau at an elevation of 2,000 to 2,400 meters. The conditions of distribution are such as to indicate that the plant has been carried up this thoroughfare by man, and in this elevated habitat it has taken on certain alpine characters including elongated roots, xerophytic leaves, stems 2 to 5 centimeters high, reddish flowers, with a noticeable increase of the hairiness of the entire plant. That the distributional history has been correctly apprehended seems entirely confirmed by the fact that when seeds are taken from the lowlands the alpine characters enumerated are displayed at once as a direct somatic response. When seeds are taken from plants on the elevated plateau where their ancestors may have been for many years or many centuries (perhaps as long as 2,000 years) and sowed at Vienna and in other cultures, carried through four generations the leaves lose their xerophytic form and structure, but the other characteristics are retained within the limits of variability. The stems show an increase in average length of 1 or 2 centimeters, the roots change as much, but the reproductive branches and floral organs retain their alpine

characters. The slight modifications undergone by these features were seen to reach a maximum and to decrease in the latest generations cultivated. The structural changes and implied functional accommodations are indutiably direct somatic responses, there is no escape from the conclusion that the impress of the alpine climate on the soma has been communicated to the germ-plasm in such manner as to be transmissible, and the suggestion lies near that repeated and continued excitation by climatic factors may have been the essential factor in such fixation.

My own earlier work with relation to this subject consisted chiefly of ovarial treatments in which the main and accessory reproductive elements of seed-plants were subjected to the direct action of solutions of various kinds. New combinations of characters constituting a distinct elementary species or genotype were obtained in one plant, and the divergent type has been found to transmit its qualities in the fullest degree as far as tested, to the fifth generation Still more marked forms were obtained in a second genus, the divergent progeny being lost in transference to the desert laboratory, while marked responses have been obtained in the extensions of these experiments upon species representing widely different morphological types in Arizona. The greater majority of the tests have been made upon plants growing under natural conditions, so that environmental reaction in addition to that of the specific reagents might be excluded. Progenies representing many species, including thousands of individuals, many of which are divergent, are now under observation. Absolute finality of decision with respect to the standing of the new types may be reached but slowly.

Gager produced chromosomic aberrations in the reducing division of *Oenothera* by irradiations and such excitation was also followed by the appearance of aberrants in the progeny, the hereditary qualities of which have not been tested. Using similar excitation Morgan induced the appearance of white eyes and of short wings in a pedigree culture of the fly, *Drosophila amelophila*. But qualities were sex-limited and mendelized when paired with the red eyes and long wings of the original type. Both, however, seem to be fully transmissible. The first results of importance from cultures widely extended geographically have been obtained in the experiments with Leptinotarsæ by Tower, in which various species of these potato beetles were studied in their habitats in southern Mexico, in open air and glass houses as far north as Chicago, as far east as the Atlantic and as far west as the Desert Laboratory. New self-maintaining forms resulted from climatic excitation and the origination of species already in existence was repeated, the varied effects secured being the most important contribution yet made to the subject.

In addition to the conclusive observations cited there is available a great mass of information concerning experiments in which negative results were obtained, the environment failing to produce any permanent effect, while in other cases the living material has not been followed through a sufficient number of generations to test its heritability. Thus Kammerer carried out some tests with salamanders three years ago that have the interest attached to any attempt to interpret geographic or habitat relations. *Salamandra maculosa* is viviparous when it lives high in the mountains and ovo-viviparous at lower levels. *S. atra* is an alpine form and the larvæ are large with very long gills. When the latter form was kept at unusually high temperatures the larvæ produced resembled those of *S. maculosa* in its lower warmer habitats. *S. maculosa* kept in low temperatures and without water showed a cumulation of effects by which the characters of the young and the reproductive habits resembled those of *S. atra*. The conditions of these experiments are not such as to allow a definite separation of somatic and germinal effects, neither was the permanency of the newly acquired habits tested to such an extent as to determine their hereditary value.

In the experiments of Sumner, mice reared in a warm room were found to differ considerably from those reared in a cold room in the mean length of the tail, foot, and ear, and the differences were transmitted to the next generation. The differences may be reasonably designated as being directly individual and somatic, and as having been transmitted by the germ-plasm, which was not subject to the action of various temperatures in the first instance. The reaction forms have an additional claim upon our attention, since they are the ones which distinguish northern and southern races of many animals. The crucial test of the value of the alterations induced in the mice is the one applicable to all of the experimentation on this subject, a test in which two parallel series of cultures, one under the altered environment and the other under casual conditions, should be kept going continuously for a long number of years, lots being withdrawn from both, from time to time, for long-continued comparative culture in normal habitat and under other conditions. Effects due solely to fluctuating variability may be expected to reach a maximum and minimum within two or three years, leaving the enduring effects standing alone, or in such relief as to be capable of ready calibration.

No little interest attaches to the evidence now accumulating to show that the hybrids between two species of plants or animals may be different in various localities or under the influence of special exciting agencies. DeVries has repeatedly called attention to the fact that the composition of hybrid progenies of mutants with each other and with the parental form might be altered by nutritive conditions, and the author has cited the fact that mutations were made by *Oenothera Lamarckiana*, the great evening primrose, in the climate of New York, which had never been seen in Amsterdam. Furthermore, in discussing the divergent results of DeVries and myself, obtained by crossing the same forms in Amsterdam and New York, the suggestion was made that "the manner in which the various qualities in the two parents are grouped in the progeny might be capable of a wide range of variation. Many indications lead to the suggestion that the dominancy and prevalency, latency and recessivity of any character may be more or less influenced by the conditions attendant upon the hybridization; the operative factors might include individual qualities as well as external conditions."

Tennent arranged a series of hybridizations of Echinoderms at Tortugas which yielded data of great interest in connection with the earlier conclusions of Vernon, Doncaster, and Herbst as to the influence of temperature and season changes upon dominance. From the information derived from crosses of Hipponoë and Toxopnoustes it is clear that the dominance of the parental characters is dependent upon the alkalinity or the concentration of the OH ions. The products of the trial cross-fertilizations, however, were not reared to maturity.

Much more striking evidence upon the matter has been recently obtained by Tower in intercrossing *Leptinotarsa decemlincata, L. multilincata, L. oblongata*, and other species of the potato beetles in their habitats in southern Mexico, and at the desert laboratory. Among other divergences one of the three first generation intermediates characteristic of these cultures was lacking from the Tucson cultures, although two other such forms were included.

In a comprehensive treatment of the entire subject with especial reference to modifications in dominance Tower says: "The experiments and observations herein given warrant the general statement that conditions external to a cross are important factors in determining the results thereof. This conclusion has been worked out in both normal and hybrid crosses, in crosses between races which have been created selectively, and between forms which arose as sports; and the second series of experiments in synthesis is sufficient warrant for attributing to this factor a considerable importance in evolution."

It is evident from the foregoing facts that the biologist is in a position to assert that external factors may affect the hereditary quality of plants and animals in a very marked manner, and that agencies of various kinds may influence the results of crossing two species. Furthermore, the experiences at hand justify the assumption that the actual transplantation of organisms from one locality to another, as a method of experimentation, promises the results of highest value and widest significance, especially when taken in connection with analytical laboratory cultures. This method of approach is one which may yield evidence of the greatest value upon the influence of isolation and other geographical factors, but is also one which allows the repetitive or mnemonic effects to be evaluated. When supplemented by laboratory analyses and cultures to determine the nature of alterations induced, such methods promise results of the greatest value.

A series of plantations, including locations from mountain tops to the seashore, has been established in connection with the Desert Laboratory in accordance with this idea, and in addition to the interchange of species from the various localities a number of introductions have been made from eastern America.

None of the attempts hitherto made to perfect a theoretical conception which would be useful in interpreting the mechanism of environic responses have had anything more than the most limited usefulness. The stimuli of climatic and many other agencies do not imply the introduction of any strange or new substances into the bodies of the organs affected. These agencies might change the dissociations in such a manner as to modify the relative number of free ions and thus alter the molecular complex of the living matter in a very important manner. The intricate play of enzymatic action might also be altered, and any modification of the relative reaction velocities of the more important processes might result in material and permanent change, especially in those cases in which external agencies interfere directly with the action of the germ-plasm.

The introduction of solutions into ovaries or the exposure of reproductive elements to unusual irradiation may arise from the additional liability of disturbed polarity and of modified surface tensions in the cells. It is conceivable that the rearrangement or disturbance of the localizations of substances, especially the mineral salts, might seriously modify the capacities of the bearers of heredity. These direct and material possibilities offer an adequate basis for the organization of experimental research upon the main subject, as well as the means of interpretation of results without recourse to schemes of particulate inheritance or theories as to the constitution of germplasm to which may be ascribed usefulness in the discussion of other problems in evolution.

The various experimental methods used in the work on the subject and the diversity of the results obtained makes it possible to formulate some useful generalizations, which may briefly be stated as follows:

It is clear that some environic effects are heritable and some are not. Negative or positive results of sufficient inclusiveness to permit analyses as to the nature of the exciting agency and the permanence of the response are not yet available. Some of the induced characters may be retracements, or regressions, as the reappearance of spines in cacti, or they may be awakened latencies or organizations *de novo*. Some of the responses may result in sexual dimorphism, while in others the induced characters may be sex-limited. The alterations induced by external agencies may be cumulative or mutative as to appearance or organization, and they may be permanent upon first appearance, or on the other hand may need generations of repetition before becoming fixed. And lastly the changes may be orthogenetic or heterogenetic as to direction, adaptive and accommodative or correlative, or wholly inutile as to their functional relations.

Clamp for Washing Negatives

By Z. C. KOMOROWSKI

THE washing of paper negatives is a very delicate operation, especially if one wants to do it very thoroughly without spoiling them and at the same time wash the hyphosulphite of soda entirely out. We illustrate herewith a little tool which will do the work very effectively, and which commends itself on account of the cheapness and the ease of construction.

Take a cork, cut it in half lengthwise, then from one of the halves cut a piece off the top, as in Fig. 1. Take a rubber band and fasten it tightly around the lower part of the cork to keep the two halves well together and insert a pin in the top of the uncut half, Fig. 2. The cork cut in this way will act as a clamp and the two halves can be opened more or less as desired.

To use this clamp open it by pressing lightly the top, insert the paper in the lower opening and then release. Put the whole in the wash basin. The cork

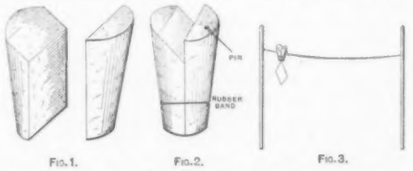


FIG. 1. FIG. 2. FIG. 3.

Clamp Made of Cork, for Use in Washing Negatives

will float on the surface, and the hyposulphite will dissolve and sink to the bottom. After you are sure that the washing has been properly done, pick up the cork and the negative and hang them by the pin to drip on a wire or cord stretched between two supports (Fig. 3.).

From the time the negative is inserted in the clamp until it is taken out dry one need not touch them with the hands, thus avoiding the danger of a scratch or a blotch.

Inspection of nursery stock imported into the United States from foreign countries has been an important item in the year's work. Much of this stock destined to many of the States and the District of Columbia, when inspected, was found to be seriously infested with brown-tail moths, or other injurious insects, and nearly 300 such shipments have been destroyed. Through the efforts of the Agricultural Department some of the offending countries have adopted inspection methods, and their shipments are likely to be less dangerous in the future.

Making Money Out of Bees—II*

Keeping Bees for Pleasure and Profit

By E. F. Phillips, Ph.D., in charge of Bee Culture, Bureau of Entomology

Concluded from Supplement No. 1833, page 110

DIRECTIONS FOR GENERAL MANIPULATIONS.

BEES should be handled so that they will be little disturbed in their work. As much as possible, stings should be avoided during manipulation. This is true not so much because they are painful to the operator, but because the odor of poison which gets into the air irritates the other bees and makes them more difficult to manage. For this reason it is most advisable to wear a black veil (Fig. 4) over a wide-brimmed hat and to have a good smoker (Fig. 3). Experienced bee keepers often dispense with these, but the beginner should not. Gloves, however, are usually more an inconvenience than otherwise. Gauntlets or rubber bands around the cuffs keep the bees from crawling up the sleeve. It is best to avoid black clothing since that color seems to excite bees; a black felt hat is especially to be avoided.

The bee keeper should manipulate without exhibiting fear. This is not because the bees recognize the fact that the operator is afraid of them, as some claim, but because superfluous quick movements tend to irritate the bees. The hive should not be jarred or disturbed any more than necessary. Rapid movements are objectionable, because with their peculiar eye structure bees probably perceive motion more readily than they do objects. Persons not accustomed to bees, on approaching a hive, often strike at bees which fly toward them or make some quick movement of the head or hand to avoid the sting which they fear is to follow. This is just what should not be done, for the rapid movement, even if not toward the bee, is far more likely to be followed by a sting than in remaining quiet.

The best time to handle bees is during the middle of warm days, particularly during a honey flow. Never handle bees at night or on cold, wet days unless absolutely necessary. The work of a beginner may be made much easier and more pleasant by keeping gentle bees. Caucasians, Carniolans, Banats, and

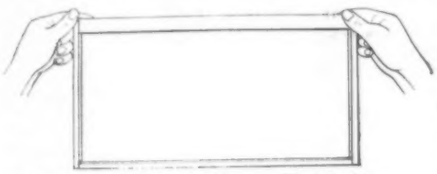


Fig. 11.—Handling the Frame: First Position

strains of Italians ordinarily do not sting much unless unusually provoked or except in bad weather. Common black bees or crosses of blacks with other races are more irritable. It may be well worth while for the beginner to procure gentle bees while gaining experience in manipulation. Later on, this is less important, for the bee keeper learns to handle bees with the least inconvenience to himself or to them.

Before opening a hive the smoker should be lighted and the veil put on. A few puffs of smoke directed into the entrance will cause the bees to fill themselves with honey and will drive back the guards. The hive cover should be raised gently, if necessary being pried loose with a screw-driver or special hive tool. As soon as a small opening is made, more smoke should be blown in on the tops of the frames, or if a mat covering for the frames is used, the cover should be entirely removed and one corner of the mat lifted to admit smoke. It is not desirable to use any more smoke than just enough to subdue the bees and keep them down on the frames. At any time during manipulation, if they become excited, more smoke may be used. Do not stand in front of the entrance, but at one side or the back.

After the frames are exposed they may be loosened by prying with the hive tool and crowded together a little so as to give room for the removal of one frame. In cool weather the propolis (bee glue) may be brittle. Care should be exercised not to loosen this with a jar. The first frame removed can be leaned against the hive, so that inside there will be more room for handling the others. During all manipulations bees must not be mashed or crowded, for that irritates the colony greatly and may make it necessary to discontinue operations. Undue crowding may also mash the queen. If bees crawl on the hands, they may be gently brushed off or thrown off.

In examining a frame always hold it over the hive, so that any bees or queen which fall may drop into it. Freshly gathered honey also often drops from the frame, and if it falls in the hive the bees can quickly clean it up, whereas if it drops outside it is untidy and may cause robbing. If a frame is temporarily leaned against the hive, it should be placed in a nearly upright position to prevent breakage and leakage of

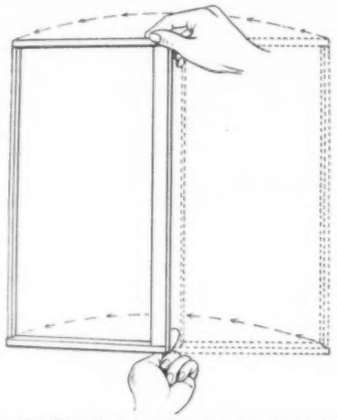


Fig. 12.—Handling the Frame: Second Position

honey. The frame on which the queen is located should not be placed on the ground, for fear she may crawl away and be lost. It is best to lean the frame on the side of the hive away from the operator, so that bees will not crawl up the legs.

In handling frames the comb should always be held in a vertical position, especially if it contains much honey. When a frame is lifted from the hive by the top bar, one side is exposed to the operator with the comb placed vertically (Fig. 11). To examine the reverse side, raise one end of the top bar until it is perpendicular (Fig. 12), turn the frame on the top bar as an axis until the reverse side is in view, and then lower to a horizontal position with the top bar below (Fig. 13). In this way there is no extra strain on the comb and the bees are not irritated. This care is not so necessary with wired combs, but it is a good habit to form in handling frames.

It is desirable to have combs all of worker cells to reduce the amount of drone brood. The use of full sheets of foundation will bring this about and is also of value in making the combs straight, so that bees are not mashed in removing the frame. It is extremely difficult to remove combs built crosswise in the hive, and this should never be allowed to occur. Such a hive is even worse than a plain box hive. Extra inside fixtures should be avoided, as they tend only to impede manipulation. The hive should also be placed so that the entrance is perfectly horizontal and a little lower than the back of the hive. The frames will then hang in a vertical position, and the outer ones

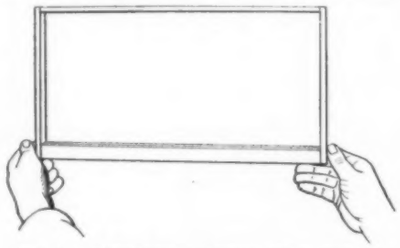


Fig. 13.—Handling the Frame: Third Position

will not be fastened to the hive body if properly spaced at the top.

Various remedies for bee stings have been advocated, but they are all useless. The puncture made by the sting is so small that it closes when the sting is removed and liquids cannot be expected to enter. The best thing to do when stung is to remove the sting as soon as possible without squeezing the poison sac, which is usually attached. This can be done by scraping it out with a knife or finger nail. After this is done the injured spot should be let alone and not rubbed with any liniment. The intense itching will soon disappear; any irritation only serves to increase the after swelling.

In placing frames in the hive great care should be exercised that they are properly spaced. Some frames are self-spacing, having projections on the side, so that when placed as close as possible they are the correct distance apart. These are good for beginners or persons who do not judge distances well and are preferred by many professional bee keepers. If unspaced frames are used, they should be 1⅜ inches from center to center. A little practice will usually enable anyone to space quickly and accurately. Careful spacing is necessary to prevent the building of combs of irregular thickness and to retard the building of pieces of comb from one frame to another.

A beginner in bee keeping should by all means, if possible, visit some experienced bee keeper to get suggestions in handling bees. More can be learned in a short visit than in a considerably longer time in reading directions, and numerous short cuts which are acquired by experience will well repay the trouble or expense of such a visit. Not all professional bee keepers manipulate in the very best way, but later personal experience will correct any erroneous information. Above all, personal experimenting and a study of bee activity are absolute necessities in the practical handling of bees.

TRANSFERRING.

In increasing the apiary it is sometimes best to buy colonies in box hives on account of their smaller cost and to transfer them to hives with movable frames. This should be done as soon as possible, for box-hive colonies are of small value as producers. The best time to transfer is in the spring (during fruit bloom in the North) when the amount of honey and the population of the colony are at a minimum.

Transferring should not be delayed until spring merely because that season is best for the work. It may be done at any time during the active season, but,

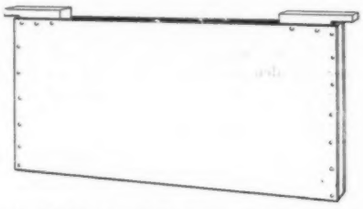


Fig. 14.—Division-board Feeder to be Hung in Hive in Place of Frame

whenever possible, during a honey flow, to prevent robbing. If necessary, it may be done in a tent such as is often used in manipulating colonies. By choosing a time of day when the largest number of bees are in the field the work will be lessened.

The box hive should be moved a few feet from its stand and in its place should be put a hive containing either full sheets of foundation or empty combs. The box hive should be turned upside down and a small, empty box fitted on it. By drumming continuously on the box hive for a considerable time the bees will be made to desert their combs and go to the upper box, and when most of them are clustered above the box may be carried to the new hive and the bees dumped in front of the entrance. The queen will usually be seen as the bees enter the hive, but, in case she has not left the old combs, more drumming will induce her to leave. It is necessary that the queen be in the hive before this manipulation is finished. The old box hive containing brood may now be placed right side up in a new location and in twenty-one days all of the worker brood will have emerged and probably some new queens will have been reared. These bees may then be drummed out and united with their former hive mates by smoking the colony and the drummed bees vigorously and allowing the latter to enter the hive through a perforated zinc to keep out the young queens. The wax in the box hive may then be melted up and any honey which it may contain used as the bee keeper sees fit. By this method good straight combs are obtained. If little honey is being gathered, the colony in the hive must be provided with food.

If, on the other hand, the operator desires to save the combs of the box hive, the bees may be drummed into a box and the brood combs and other fairly good combs cut to fit frames and tied in place or held with rubber bands, strings, or strips of wood until the bees can repair the damage and fill up the breaks.

* Farmer's Bulletin No. 397, United States Department of Agriculture.

These frames can then be hung in a hive on the old stand and the bees allowed to go in. The cutting of combs containing brood with more or less bees on them is a disagreeable job, and since the combs so obtained are usually of little value in an apiary, the first method is recommended.

Colonies often take up their abode in walls of houses and it is often necessary to remove them to prevent damage from melting combs. If the cavity in which the combs are built can be reached the method of procedure is like that of transferring, except that drumming is impractical and the bees must simply be subdued with smoke and the combs cut out with the bees on them.

Another method which is often better is to place a bee escape over the entrance to the cavity, so that the bees can come out, but cannot return. A cone of wire cloth about 8 inches high with a hole at the apex just large enough for one bee to pass will serve as a bee escape, or a regular bee escape such as are sold by dealers may be used. A hive which they can enter is then placed beside the entrance. The queen is not obtained in this way, and, of course, goes right on laying eggs, but as the colony is rapidly reduced in size the amount of brood decreases. As brood emerges, the younger bees leave the cavity and join the bees in the hive, until finally the queen is left practically alone. A new queen should be given to the bees in the hive as soon as possible, and in a short time they are fully established in their new quarters. After about four weeks, when all or nearly all of the brood in the cavity has emerged, the bee escape should be removed and as large a hole made at the entrance of the cavity as possible. The bees will then go in and rob out the honey and carry it to the hive, leaving only empty combs. The empty combs will probably do no damage, as moths usually soon destroy them and they may be left in the cavity and the old entrance carefully closed to prevent another swarm from taking up quarters there.

In transferring bees from a hollow tree the method will depend on the accessibility of the cavity. Usually it is difficult to drum out the bees and the combs can be cut out after subduing the colony with smoke.

UNITING.

Frequently colonies become queenless when it is not practicable to give them a new queen, and the best practice under such conditions is to unite the queenless bees to a normal colony. If any colonies are weak in the fall, even if they have a queen, safe wintering is better insured if two or more weak colonies are united, keeping the best queen. Under various other conditions which may arise the bee keeper may find it desirable to unite bees from different colonies. Some fundamental facts in bee behavior must be thoroughly understood to make this a success.

Every colony of bees has a distinctive colony odor and by this means bees recognize the entering of their hive by bees from other colonies and usually resent it. If, however, a bee comes heavily laden from the field and flies directly into the wrong hive without hesitation, it is rarely molested. In uniting colonies, the separate colony odors must be hidden, and this is done by smoking each colony vigorously. It may at

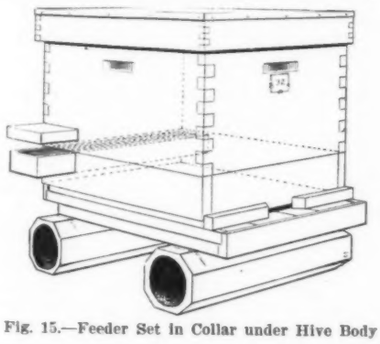


Fig. 15.—Feeder Set in Collar under Hive Body

times be desirable to use tobacco smoke, which not only covers the colony odor but stupefies the bees somewhat. Care should be taken not to use too much tobacco, as it will completely overcome the bees. The queen to be saved should be caged for a day or two to prevent the strange bees from killing her in the first excitement.

Another fact which must be considered is that the bees of a colony carefully mark the location of their own hive and remember that location for some time after they are removed. If, therefore, two colonies in the apiary which are not close together are to be united, they should be moved gradually nearer, not more than a foot at a time, until they are side by side, so that the bees will not return to their original locations and be lost. As the hives are moved gradually the slight changes are noted and no such loss occurs. As a further precaution, a board should be placed in front of the entrance in a slanting position, or brush and weeds may be thrown down so that when the bees fly out they recognize the fact that there has been a change and accustom themselves to the new place. If uniting can be done during a honey flow, there is less danger of loss by bees fighting, or if done in cool weather, when the bees are not actively rearing brood, the colony odors are diminished and the danger is reduced.

It is an easy matter to unite two or more weak swarms to make one strong one, for during swarming the bees have lost their memory of the old location, are full of honey, and are easily placed wherever the bee keeper wishes. They may simply be thrown together in front of a hive. Swarms may also be given to a newly established colony with little difficulty.

PREVENTING ROBBING IN THE APIARY.

When there is no honey flow bees are inclined to rob other colonies, and every precaution must be taken to

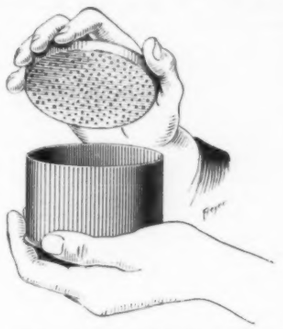


Fig. 16.—"Pepper-box" Feeder for Use on Top of Frames

prevent this. Feeding often attracts other bees, and, if there are indications of robbing, the sirup or honey should be given late in the day. As soon as robbing begins, manipulation of colonies should be discontinued, the hives closed, and, if necessary, the entrances contracted as far as the weather will permit. If brush is thrown in front of the entrance, robbers are less likely to attempt entering. At all times honey which has been removed from the hives should be kept where no bees can get at it, so as not to incite robbing.

FEEDING.

During the spring manipulations, in preparing bees for winter, and at other times it may be necessary to feed bees for stimulation or to provide stores. *Honey from an unknown source should never be used*, fear of introducing disease, and sirup made of granulated sugar is cheapest and best for this purpose. The cheaper grades of sugar or molasses should never be used for winter stores. The proportion of sugar to water depends on the season and the purpose of the feeding. For stimulation a proportion of one-fourth to one-third sugar by volume is enough, and for fall feeding, especially if rather late, a solution containing as much sugar as it will hold when cold is best. There seems to be little advantage in boiling the sirup. Tartaric acid in small quantity may be added for the purpose of changing part of the cane sugar to invert sugar, thus retarding granulation. The medication of sirup as a preventive or cure of brood disease is often practiced, but it has not been shown that such a procedure is of any value. If honey is fed, it should be diluted somewhat, the amount of dilution depending on the season. If robbing is likely to occur, feeding should be done in the evening.

Numerous feeders are on the market, adapted for different purposes and methods of manipulation (Figs. 14, 15, 16). A simple feeder can be made of a tin pan filled with excelsior or shavings (Fig. 17). This is filled with sirup and placed on top of the frames in a super or hive body. It is advisable to lean pieces of wood on the pan as runways for the bees, and to attract them first to the sirup, either by mixing in a little honey or by spilling a little sirup over the frames and sticks. It may be stated positively that it does not pay financially, or in any other way, to feed sugar sirup to be stored in sections and sold as comb honey. Of course, such things have been tried, but the consumption of sugar during the storing makes the cost greater than the value of pure floral honey.

SPRING MANAGEMENT.

The condition of a colony of bees in the early spring depends largely on care in the preceding autumn and in the method of wintering. If the colony has wintered well and has a good prolific queen, preferably young, the chances are that it will become strong in time to store a good surplus when the honey flow comes.

The bees which come through the winter, reared the previous autumn are old and incapable of much work. As the season opens they go out to collect the early nectar and pollen, and also care for the brood which hatches from the eggs laid by the queen. The amount of brood is at first small, and as the new workers emerge they assist in the brood rearing so that the extent of the brood can be gradually increased until it reaches the maximum at the beginning of the summer. The old bees die off rapidly.

If brood rearing does not continue late in the fall, so that the colony goes into winter with a large percentage of young bees, the old bees may die off in the spring faster than they are replaced by the emerging brood. This is known as "spring dwindling." A remedy for this may be applied by feeding, if necessary, the autumn before, or keeping up brood rearing by some other means as late as possible.

If spring dwindling begins, however, it can be diminished somewhat by keeping the colony warm and by stimulative feeding, so that all the energy of the old bees may be put to the best advantage in rearing brood to replace those dying off. The size of the brood chamber can also be reduced to conserve heat.

It sometimes happens that when a hive is examined in the spring the hive body and combs are spotted with brownish yellow excrement. This is an evidence of what is commonly called "dysentery." The cause of this trouble is long-continued confinement with a poor quality of honey for food. Honey-dew honey and some of the inferior floral honeys contain a relatively large percentage of material which bees cannot digest, and, if they are not able to fly for some time, the intestines become clogged with fæcal matter and a diseased condition results. Bees never normally deposit their fæces in the hive. The obvious preventive for this is to provide the colony with good honey or sugar sirup the previous fall. "Dysentery" frequently entirely destroys colonies, but if the bees can pull through until warm days permit a cleansing flight they recover promptly.

Bees should not be handled in the early spring any more than necessary, for to open a hive in cool weather wastes heat and may even kill the brood by chilling. The hive should be kept as warm as possible in early spring as an aid to brood rearing. It is a good practice to wrap hives in *black* tar paper in the spring, not only that it may aid in conserving the heat of the colony, but in holding the sun's heat rays as a help to the warmth of the hive. This wrapping should be put on as soon as an early examination has shown the colony to be in good condition, and there need be no hurry in taking it off. A black wrapping during the winter is not desirable, as it might induce brood rearing too early and waste the strength of the bees.

As a further stimulus to brood rearing, many bee keepers practice stimulative feeding of sugar sirup in early spring. This produces the same effect as a light honey flow does and the results are good. Others prefer to give the bees such a large supply of stores in the fall that when spring comes they will have an abundance for brood rearing, and it will not be necessary to disturb them in cool weather. Both ideas are good, but judicious stimulative feeding usually more than pays for the labor. Colonies should be fed late in the day, so that the bees will not fly as a result of

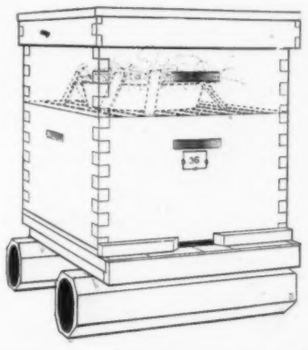


Fig. 17.—Pan in Super Arranged for Feeding

this, and so that robbing will not be started. When the weather is warmer and more settled, the brood cluster may be artificially enlarged by spreading the frames so as to insert an empty comb in the middle. The bees will attempt to cover all the brood that they already had, and the queen will at once begin laying in the newly inserted comb, thus making a great increase in the brood. This practice is desirable when carefully done, but may lead to serious results if too much new brood is produced. A beginner had better leave the quantity of brood to the bees.

It is desirable, early in the season, before any preparations are made for swarming, to go through the apiary and clip one wing of each queen so that if a swarm issues the queen cannot fly and the bees can be easily returned to the old stand. This should be done before the hive becomes too populous. It is perhaps best to clip queens as they are introduced, but some colonies may rear new ones without the knowledge of

the owner, and a spring examination will insure no escaping swarms.

Queens sometimes die during the winter and early spring, and since there is no brood from which the bees can replace them, the queenless colonies are "hopelessly queenless." Such colonies are usually restless and are not active in pollen gathering. If, on opening a colony, it is found to be without a queen and reduced in numbers, it should be united with another colony by smoking both vigorously and caging the queen in the queen-right colony for a day or two to prevent her being killed. A frame or two of brood may be added to a queenless colony, not only to increase its strength, but to provide young brood from which they can rear a queen. Bee keepers in the North can frequently buy queens from southern breeders early in the spring, and naturally this is better than leaving the colony without a queen until the bees can rear one, as it is important that there be no stoppage in brood rearing at this season.

SWARM MANAGEMENT AND INCREASE.

The excessive rearing of brood at the wrong season or increase in the number of colonies greatly reduces the surplus honey crop by consumption. The ideal to which all progressive bee keepers work, when operating simply for honey, is to stimulate brood rearing to prepare bees for gathering, to retard breeding when it is less desirable, and to prevent swarming. Formerly the measure of success in bee keeping was the amount of increase by swarming, but this is now recognized as being quite the contrary of success.

The stimulation of brood rearing in the spring, however makes it more likely that swarming will occur; so that the operator must counteract that tendency. This is especially true in comb-honey production. Very few succeed in entirely preventing swarming, but by various methods the situation can be largely controlled.

When a swarm issues, it usually first settles on a limb of a tree or bush near the apiary. It was formerly common to make a noise by beating pans or ringing bells in the belief that this causes the swarm to settle. There is no foundation for such action on the part of the bee keeper. If the bees light on a small limb that can be spared, it may simply be sawed off and the bees carried to the hive and thrown on a sheet or hive cover in front of the entrance. If the limb cannot be cut, the swarm can be shaken off into a box or basket on a pole and hived. If the bees light on the trunk of a tree or in some inaccessible place, they can first be attracted away by a comb, preferably containing unsealed brood. In these manipulations it is not necessary to get all the bees, but if the queen is not with those which are put in the hive the bees will go into the air again and join the cluster.

If a queen is clipped as recommended under "Spring management" the swarm will issue just the same, but the queen, not being able to fly, will simply wander about on the ground in front of the hive, where she can be caught and caged. The parent colony can then be removed to a new stand and a new hive put in its place. The bees will soon return and the queen can be freed among them as they enter. The field bees on returning will enter the new hive with the swarm, thus decreasing still more the parent colony and making a second swarm less probable. To make sure of this, however, all queen cells except one good one can be removed soon after the swarm issues. To hold a swarm it is desirable to put one frame containing unsealed brood in the new hive. The other frames may contain full sheets or starters of foundation or drawn combs. Usually comb-honey supers or surplus bodies for extracting frames will have been put on before swarming occurs. These are given to the swarm on the old stand and separated from the brood chamber by queen-excluding perforated zinc.

When clipping the queen's wing is not practised, swarms may be prevented from leaving by the use of queen traps of perforated zinc (Fig. 6). These allow the workers to pass out, but not drones or queens which, on leaving the entrance, pass up to an upper compartment from which they cannot return. These are also used for keeping undesirable drones from escaping, and the drones die of starvation. When a swarm issues from a hive provided with a queen trap, the queen goes to the upper compartment and remains there until released by the bee keeper. The workers soon return to the hive. When the operator discovers the queen outside, the colony may be artificially swarmed to prevent another attempt at natural swarming. A queen trap should not be kept on the hive all the time for fear the old queen may be superseded and the young queen prevented from flying out to mate.

ARTIFICIAL SWARMING.

If increase is desired, it is better to practice some method of artificial swarming and to forestall natural swarming rather than be compelled to await the whims of the colonies. The situation should be under the control of the bee keeper as much as possible. The bees, combs, and brood may be divided into two nearly equal parts and a queen provided for the queenless portion; or small colonies, called nuclei, may be made from the parent colony, so reducing its strength that swarming is not attempted. These plans are not as satisfactory as shaken swarms, since divided colonies lack the vigor of swarms.

A good method of artificially swarming a colony is to shake most of the bees from the combs into a new hive on the old stand with starters (narrow strips) of foundation. The hive containing the brood with some bees still adhering is then moved to a new location. If receptacles for surplus honey have been put on previously, as they generally should be, they should now be put over the artificial swarm separated from the brood compartment by perforated zinc.

This method of artificially swarming (usually called by bee keepers "shook" swarming) should not be practiced too early, since natural swarming may take place later. The colony should first have begun its preparations for swarming. The method is particularly useful in comb-honey production. The bees may be prevented from leaving the hive by the use of a drone trap (Fig. 6) or by putting in one frame containing unsealed brood. Some bee keepers prefer using full sheets of foundation or even drawn combs for the artificial swarm, but narrow strips of foundation have some advantages. By using narrow strips the queen has no cells in which to lay eggs for a time, thus reducing brood rearing, but since by the time artificial swarming is practised the profitable brood rearing is over, this is no loss but rather a gain. There are also in the brood compartment no cells in which the gathering workers can deposit fresh honey, and they consequently put it above in the supers. Gradually the combs below are built out and brood rearing is increased. Late the colony is allowed to put honey in the brood combs for its winter supply. If no increase is desired, the bees which emerge from the removed brood combs may later be united with the artificial swarm and by that time there will usually be little danger of natural swarming.

PREVENTION OF SWARMING.

Unless increase is particularly desired, both natural and artificial swarming should be done away with as far as possible, so that the energy of the bees shall go into the gathering of honey. Since crowded and overheated hives are particularly conducive to swarming, this tendency may be largely overcome by giving plenty of ventilation and additional room in the hive. Shade is also a good preventive of swarming. Extra space in the hive may be furnished by adding more hive bodies and frames or by frequent extracting, so that there may be plenty of room for brood rearing and storage at all times. These manipulations are, of course, particularly applicable to extracted-honey production.

To curb the swarming impulse frequent examinations of the colonies (about every week or ten days during the swarming season) for the purpose of cutting out queen cells is a help, but this requires considerable work, and since some cells may be overlooked, and particularly since it frequently fails in spite of the greatest care, it is not usually practiced. Requeening with young queens early in the season, when possible, generally prevents swarming.

Swarming is largely due to crowded brood chambers, and since eggs laid immediately before and during the honey flow do not produce gatherers, several methods have been tried of reducing the brood. The queen may either be entirely removed or be caged in the hive to prevent her from laying. In either event the bees will usually build queen cells to replace her, and these must be kept cut out. These plans would answer the purpose very well were it not for the fact that queenless colonies often do not work vigorously. Under most circumstances these methods cannot be recommended. A better method is to remove brood about swarming time and thus reduce the amount. There are generally colonies in the apiary to which frames of brood can be given to advantage.

In addition to these methods various non-swarming devices have been invented, and later a non-swarming hive so constructed that there is no opportunity for bees to form a dense cluster. The breeding of bees by selecting colonies with less tendency to swarm has been suggested, but nothing has been accomplished along that line.

On the whole, the best methods are the giving of plenty of room, shade, ventilation to colonies run for extracted honey; and ventilation, shade and artificial swarming of colonies run for comb honey. Frequent requeening (about once in two years) is desirable for other reasons, and requeening before swarming time helps in the solution of that difficulty.

(To be continued.)

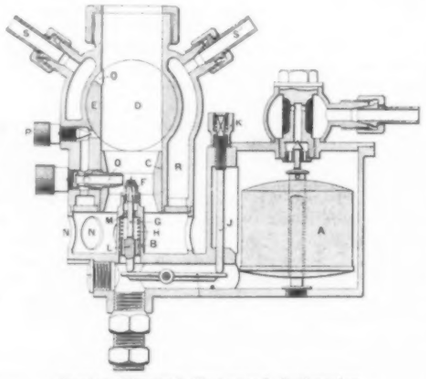
A Variable-Speed Carbureter

By the Paris Correspondent of the SCIENTIFIC AMERICAN

THE extent to which the automobile has come into use for cab service in large cities has given rise to a somewhat difficult problem in carbureter design. Vehicles of this kind are necessarily driven at low speed over a considerable portion of their travel, owing to the congestion of city traffic. Now, ordinarily, a carbureter designed for normal speeds will not function satisfactorily and economically at low speeds.

One solution of the problem is to provide a double carbureter, which in one setting is adapted for high speed work, and in another setting gives good economy at low speed. Such is the new Longuemare carbureter recently tested in the laboratories of the Paris Automobile Club, and described by M. G. Lumet, chief engineer of that laboratory.

The device is shown in section in our illustration. It consists of the usual float-feed chamber attached to the carbureter proper. From the feed chamber, the gasoline passes into a cylindrical tube *B*, through a series of holes in a stopper *L* fitted into the lower end of the tube. Fixed on the stopper is a rod *G* terminating above in a point. At the upper part of the tube there is a second set of holes *M* by which the gasoline reaches the spray nozzle *F*. This latter is a small piece screwed on to its seat, and receives the pointed end of the rod, forming a needle valve controlling the spray orifice. The stopper *L* has a sliding fit in the tube and is normally pushed down by the spring *H* against the action of the horizontal lever, engaging the lower extremity of *L*. The other end of this lever is regulated by the rod *J*, which is threaded at the top and can then be readily adjusted from outside so as to give the proper section to the spray orifice. The lock-nut *K* holds rod *J* in position. If desired the nut can have ratchet



Section Through Two-speed Carbureter

teeth cut in it, so as to fix the screw in a certain number of definite positions, and this will give corresponding standard sections for the spray.

The air enters at the base of the carbureter through openings *N*, arranged around the cylinder. From the lower part it mounts through the narrowed portion *U* so that it passes by the spray orifice at the maximum speed. The usual carbureting action takes place, and the air and gas mixture passes by *D* to the motor. The portion *D* acts as valve, and can be turned by an outside handle in the manner of a gas cock, when it is desired to set the carbureter for low speed. As above described, the carbureter is designed to work under normal conditions of speed. The second part of the carbureter comes into use for the slow motor speed as well as for starting the automobile. By turning the key *D* from right to left the orifice is gradually cut down and finally reduced to zero, and the gas is now cut off from the motor. But at this moment a notch *Q*, in the key, comes to the bottom and uncovers another passage leading from the carbureter to the motor, as will be seen on the left of the drawing. The sections for the screw passage are calculated to suit the conditions of slow motor speed. A nozzle *O* lies just opposite the spray orifice, its distance from the spray being controlled by a screw adjustment and arranged to suit the conditions of slow running as nearly as possible. This adjustment means is further supplemented by working the joint-valve *P*, so as to cut off the gas inlet more or less. The carbureter is heated by hot water jacket *R* fed from the pipe *S*.

The carbureter here described is built for two settings. Evidently the same general principle could be applied to design an apparatus giving a greater number of graded settings.

Preservation of Drawings (in pencil and India ink).—They should be coated with collodion (photographic) after 2 per cent of stearine has been added to it. The drawing is laid on a sheet of glass or a board and the collodion poured over it. After 10 to 20 minutes the drawing is dry and perfectly white.

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The Relation of Light to the Production of Sugar in Beets

THERE has been found a great deal of variation in the sugar yield of certain high grade strains of sugar-beets when grown in different localities. The variations were such as could not be accounted for by the differences in the soil, in methods of cultivation or in fertilizers. During the past two seasons (1909, 1910) experiments were conducted in Utah to determine to what extent the differences in the amount of light were responsible for the differences in the amount of sugar.

A long row of beets, planted under the usual field conditions, was selected. A portion of this row was shaded with white bunting; another portion with two thicknesses of bunting; a third with three thicknesses; and the remainder of the row left open to the full light. Of course the shading resulted also in a cutting off of the heat rays from the sun, so that it is impossible to attribute all of the differences found to a reduction in the light; but the temperature differences were very slight compared to the light differences.

The relative light intensities, based on the actual duration of bright sunshine and diffused daylight throughout the entire season, ranged from 100 for the open portion of the row to about 10 for the part most shaded; the temperature range was from 112 deg. F. in the open row in full sunshine, to 94 deg. F. in the most shaded part. The beets ranged in weight from an average of 27¾ oz. to 1¾ oz., and the sugar content varied from 3.8 oz. to 0.15 oz.—that is, in the full light there was produced more than twenty-five times as much sugar as in the most shaded region.

It appears also that not only is the actual amount of sugar affected by the amount of light, but even the purity of the juice; this ranged from 76.7 per cent at one end to 61 per cent in the most shaded portion. Not only then would the farmer get a better yield from growing the beets in fields or localities with a maximum of light exposure, but the beets raised under such conditions could be more economically utilized at the sugar mill.

Moire Decoration on Sheet Tin.—*a.* Carefully warm evenly tinned sheet iron (sheet tin) until the tin coating is just melting (to about 536 deg.) and quickly throw it into the following mixture: 2 parts chloride of tin in 4 parts water, 1 part commercial nitric acid, and 2 parts hydrochloric acid. After drying, coat, if desired, with shellac solution tinted with aniline color. *b.* If a piece of tin be heated in one place by contact with a hot soldering iron, as over the flame of a light, the tinning, within a circular space, will be melted and after cooling and etching with hydrochloric acid will display a fairly regular, radial star-shaped figure. If we pass over the sheet tin with the soldering iron or the flame, in a line, grain-ear shaped strips will result and by this means, garlands, names, and ornaments can be produced on the tin. If it is desired to cover a sheet uniformly with crystals, it should be evenly heated over a coal fire, until the tin begins to melt. If water is then thrown on it, in a fine spray, each drop of water falling on it will form a center of crystallization. If the water is caused to flow, by inclining the plate, a striped or veined pattern will result. If the heated plate is immersed in an inclined direction, in cold water, a fine moiré, of granite-like design, will be produced. After cooling, it can be etched by waxing, in dilute hydrochloric acid, to which some nitric acid has been added. The sheet of tin is then to be washed with clean water, then treated with some caustic potash, to remove any oxide of tin that may have formed, and finally, again rinsed with clean water. Finally, the moiré is coated with a transparent varnish.

Considerable interest in being awakened in Norway and Sweden as regards the manufacture of steel by the electric furnace process. The Norwegian daily papers state that one of the leading officials of the Great Swedish Copper Company, M. Lundberg, has been engaged in the construction of an electric steel furnace on the Grönwall type which is designed for 4,000 horse-power, and he expects to begin operating it in the near future. Owing to the prominent position which he occupies among iron men, the announcement caused somewhat of a stir. However, other steel furnaces are erecting in the Scandinavian region. The Swedish syndicate of iron manufacturers known as "Eisenkontor" is building a 2,500 horse-power electric steel furnace of the same type. It is located at the Trolhattan fall near the great hydro-electric plant. The sum of 250,000 crowns has been allotted for testing the adaptability of various kinds of Swedish ores for the process. Matters are also active in Norway, and by next spring it is expected to have the electric iron and steel plant in operation on the Hardongar. It has an output of about 4,000 horse-power. Two of the leading Russian iron works are taking up the question of electric steel manufacture, and they have purchased the rights for the Heroult-Lindenburg process. One of these firms is the Sormovo Iron Works and the other the Makievka Blast Furnaces and Steel Works in the Donetz basin.

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